STATE OF NEW YORK

DEPARTMENT OF CONSERVATION

WATER RESOURCES COMMISSION

Ground-Water Studies in Saratoga County, New York

By
R. C. Heath, F. K. Mack, and J. A: Tannenbaum
Geologists, U. S. Geological Survey

[redacted]

Prepared by the
U. S. GEOLOGICAL SURVEY
in cooperation with the
NEW YORK WATER RESOURCES COMMISSION,
U. S. ATOMIC ENERGY COMMISSION,
and the
U. S. NATIONAL PARK SERVICE

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PREFACE

This bulletin is one of a series published by the New York Water Resources Commission (successor to the Water Power and Control Commission) containing the results of ground-water studies made by the U. S. Geological Survey in cooperation with the Commission. Previous reports in the series are listed on the back cover. The index map (fig. I-1) shows Saratoga County and the other areas in New York, exclusive of Long Island, for which reports have been published or where investigations are in progress.

The investigation of the ground-water resources of Saratoga County was undertaken by the U. S. Geological Survey in 1946 in cooperation with the New York Water Power and Control Commission as a part of a systematic survey of the ground-water resources of the State. By the end of 1948 the collection of data on selected wells throughout the county had been essentially completed. However, because of a shortage of personnel and the urgent need to complete studies underway in several other areas, work on the countywide study had to be suspended.

In 1948, the Geological Survey began an investigation of the geology and ground-water resources of a small area surrounding the atomic-reactor research installation built near West Milton in the southwestern part of the county by the U. S. Atomic Energy Commission. The first phase of this investigation was restricted essentially to the government-owned reservation of 4,000 acres. In 1952, the studies were extended at the request of the Atomic Energy Commission to include an inventory of wells from the hamlet of West Milton to the village of Ballston Spa.

In 1958 and 1959, the Geological Survey made an investigation of the ground-water resources in Saratoga National Historical Park and vicinity in the east-central part of the county at the request of the U. S. National Park Service. The investigation consisted of two phases; (1) a brief study of the different water-bearing deposits in the area, and (2) a study of the water-bearing characteristics of the surficial sand deposit that underlies the northeastern part of the park.

Because of the rapid development of the county, and consequently the growing need for information on the ground-water resources, the principal results of the studies that have been made are brought together in this report. As soon as the availability of funds and other conditions permit, it is expected that additional field studies will be made and a comprehensive report on the ground-water resources of the county will be prepared. In the meantime, this report should provide answers to many of the questions that arise from time to time concerning the occurrence and availability of ground water.

This report is divided into three parts. Part I summarizes the geology, the ground-water resources, and the construction and other features of selected water wells and test holes in the county. Part II is a report on the ground-water resources of the West Milton area, and Part III is a report on the ground-water resources of Saratoga National Historical Park and vicinity.

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GROUND-WATER STUDIES IN SARATOGA COUNTY, NEW YORK

By

R. C. Heath, F. K. Mack, and J. A. Tannenbaum

ABSTRACT

Ground-water supplies adequate for domestic and farm needs and small industries are available throughout Saratoga County in east central New York. The ground-water aquifers consist of unconsolidated deposits of till, sand, and gravel, and consolidated sandstone, shale, carbonate, and crystalline rocks. Large supplies are available from some sand and gravel aquifers that occupy parts of the large valleys.

Till, an unsorted mixture of particles ranging in size from clay to boulders, is the principal unconsolidated deposit in the western two-thirds of the county. Small supplies of water are generally derived from large-diameter dug wells extending only a few feet below the water table. The depths of 98 dug wells, most of which draw from till, average 17 feet.

Stratified deposits of sand and gravel underlie large areas in the eastern part of the county and parts of the stream valleys in the other areas. In the eastern part these deposits are predominantly a fine to coarse sand which is underlain by clay. In these deposits supplies of water adequate for domestic needs can generally be obtained from small-diameter driven wells. The depths of 36 driven wells average 20 feet. With proper development yields of over 30 gpm (gallons per minute) have been obtained.

A special study was made of a thin sand deposit in Saratoga National Historical Park near the Hudson River. The deposit consists mainly of fine to coarse sand with a maximum thickness of 25 feet and occupies an area of about one-half square mile. Principal discharge from the deposit is a flow of about 35 gpm from a spring developed at the contact with the underlying clay. A pumping test conducted on a 2-inch-diameter well equipped with a 60-gauze screen 5 feet long jetted to a depth of 25 feet indicated a permeability of 700 gpd/ft^2 (gallons per day per square foot) and a storage coefficient of 0.16, which indicates water-table conditions. In the first 4 minutes of the test the aquifer responded as an artesian aquifer, apparently in response to silty layers.

The sand and gravel deposits in the stream valleys are capable of yielding as much as 800 gpm to a single screened well. Ground water in the valley of Kayaderosseras Creek near the reactor site at West Milton, in the southwestern part of the county, occurs under water-table and artesian conditions. The water-table aquifer is a layer of sand and gravel 25 feet thick which yields 750 gpm to a well with horizontal collectors parallel to and 25 feet from the creek. The artesian aquifer is composed of sand and some gravel 75 feet thick which is separated from the water-table aquifer by 25 feet of silt. The artesian aquifer has a transmissibility of 125,000 gpd/ft^2 and a storage coefficient of about 0.0003.

Yields of 156 wells tapping the bedrock aquifers average 13 gpm. Nine wells in the Precambrian crystalline rocks occurring in the northwest and northcentral part of the county yield an average of 6 gpm. Twelve wells in the Potsdam Sandstone and Theresa Dolomite, bordering the crystalline rocks, yield an average of 19 gpm. Twenty-five wells in the carbonate rocks which border the sandstone or, where they are absent, border the crystalline rocks yield an average of 31 gpm. One-hundred and ten wells in the shale that underlies most of the eastern and southern parts of the county yield an average of 9 gpm.

The report contains maps of the principal unconsolidated deposits and bedrock formations in the county together with records of several hundred selected wells.

PART I

SUMMARY OF GROUND-WATER CONDITIONS IN SARATOGA COUNTY

By

Ralph C. Heath

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PART I

SUMMARY OF GROUND-WATER CONDITIONS IN SARATOGA COUNTY

By Ralph C. Heath

INTRODUCTION

The investigation of the ground-water resources of Saratoga County was begun in 1948 by the U. S. Geological Survey in cooperation with the State Water Resources Commission. The initial phase of the investigation consisted of the collection of records of the depth, diameter, yield, and other features of several hundred wells relatively evenly spaced over the county. Some of these records together with records of some of the wells for which information was collected during the course of detailed studies made for the U. S. Atomic Energy Commission and the U. S. National Park Service are contained in table I-3. The text includes a brief discussion of the geology and ground-water resources of the county. Illustrations show the locations of wells and test holes for which data are included and the type of unconsolidated deposits and type of bedrock underlying each part of the county.

Most of the data on wells and test holes on which this report is based were collected from well drillers and well owners by Harry Wilson and V. H. Rockefeller. The collection of the records was supervised by M. L. Brashears, Jr., and E. S. Asselstine. The report was prepared under the supervision of G. C. Taylor, Jr., formerly district geologist.

Saratoga County is in the east-central part of New York. The counties surrounding it are Warren County on the north, Washington and Rensselaer Counties on the east, Albany and Schenectady Counties on the south, and Fulton and Hamilton Counties on the west. The northeastern and eastern boundaries of the county are formed by the Hudson River and the southeastern boundary is formed by the Mohawk River. The county contains 814 square miles and has a maximum length (north-south) of about 44 miles and a maximum width (east-west) of about 28 miles. The population of the county according to the 1960 census was 88,134. Most of the population is concentrated in the lowlands adjacent to the Hudson and Mohawk Rivers in the eastern and southern parts of the county. The northwestern part of the county extends into the Adirondack Mountains and is relatively thinly populated.

Well-Location System

The locations of the wells and test holes for which records are contained in this report are shown in figures I-5, II-4, and III-1. The wells and test holes are numbered serially in the order in which the records were collected. Each well number in Saratoga County is preceded by the symbol "Sa." However, the prefix has been omitted from the well numbers on the well-location maps because all wells are in Saratoga County. As an aid in locating wells in New York State, meridians of longitude at 15-minute intervals are lettered consecutively from west to east, beginning with "A" for meridian 79°45', and ending with "Z" for meridian 73°30'. Similarly, parallels of latitude are numbered at 15-minute intervals from north to

south beginning with "1" for parallel 45°00' and ending with "17" for parallel 41°00'. Intersections of the coordinates form points from which the location of an individual well can be described by distance and direction. All well and test-hole locations in Saratoga County are referred to the intersections of coordinates 8 (lat 43°15') or 9 (lat 43°00') and X (long 74°00') or Y (long 73°45'). The distance in miles and the direction from one of these intersections are given in the "Location" column in table I-3. For example, well Sa 1 (8Y, 3.6N, 7.3E) can be found by locating the point where lines "8" and "Y" intersect and measuring 3.6 miles north and 7.3 miles east.

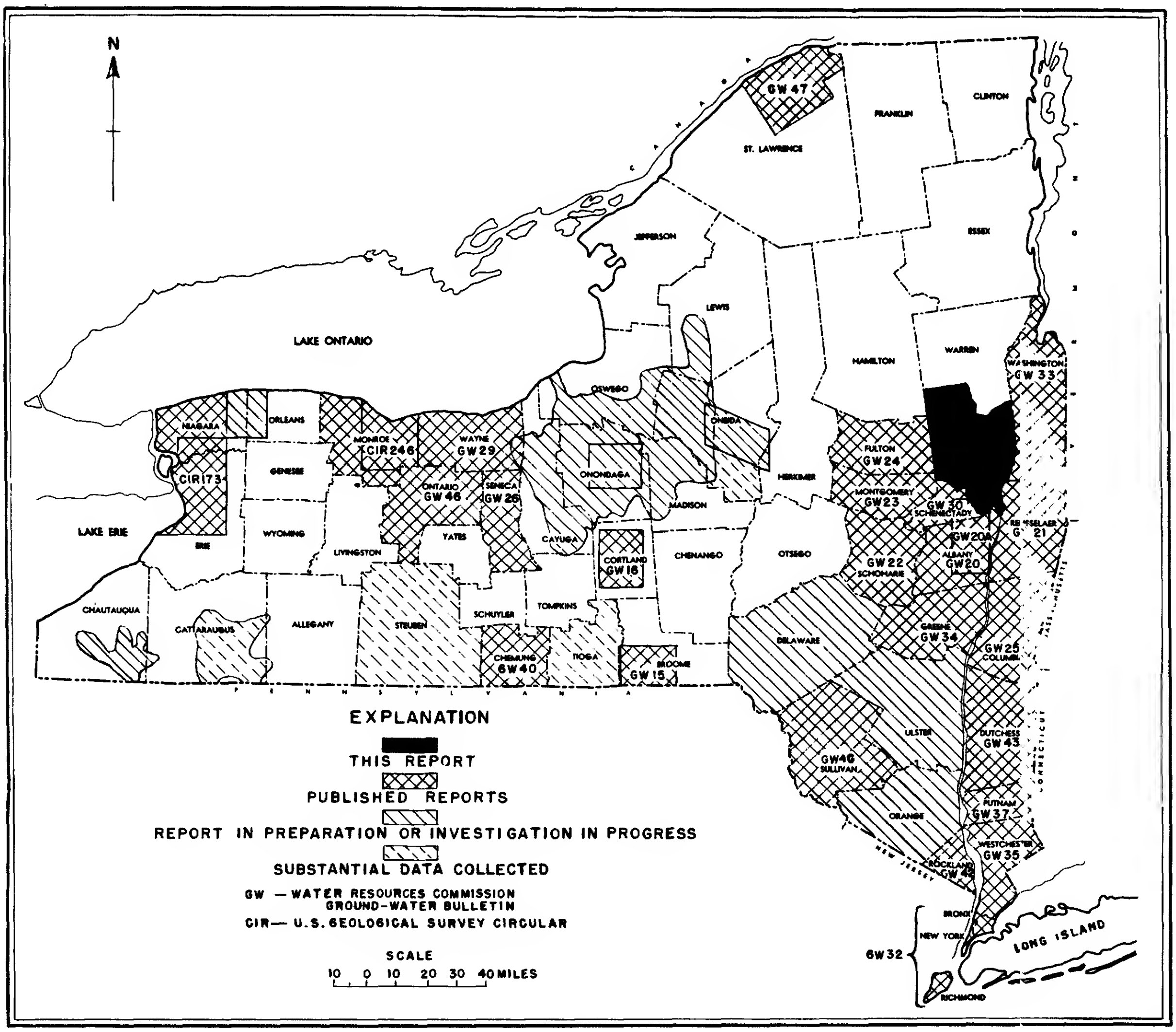

Figure I-1.--Map of New York, exclusive of Long Island, showing location of Saratoga County and status of ground-water investigations.

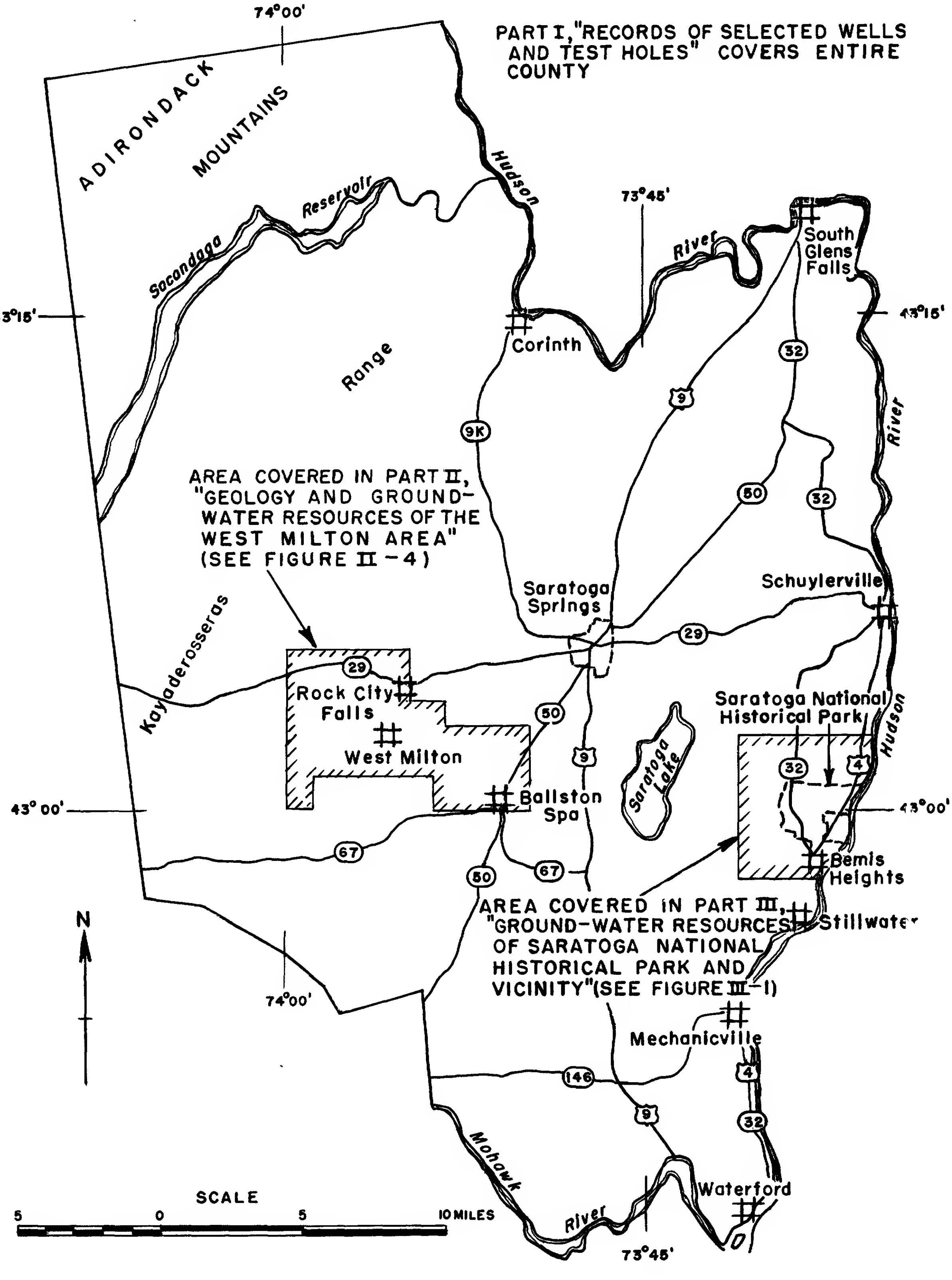

Figure I-2.--Map of Saratoga County showing areas in which ground-water investigations have been made.

GEOLOGY AND GROUND WATER

Saratoga County is underlain by two distinctly different types of "rock." Most of the surface is composed of a layer of unconsolidated deposits (also erroneously termed "soil") ranging in thickness from a few feet on some hills to more than 100 feet in parts of the lowlands adjacent to the Hudson and Mohawk Rivers. The layer of unconsolidated deposits is underlain every place in the county by consolidated rocks (also termed "bedrock") thousands of feet thick. Where the unconsolidated deposits are absent consolidated rocks form the surface. Both the unconsolidated deposits and the consolidated rocks are divisible into several different units. The subdivision of either may be based, depending on the objective of a particular study, on several different criteria. For instance, the rocks underlying most areas are of different ages and in certain geologic studies the principal subdivision is based on age. In other studies, as for example in studies of the occurrence and availability of ground water, unconsolidated deposits are generally subdivided on the basis of grain size and degree of sorting, and consolidated rocks are subdivided on the basis of type of openings and mineral composition.

From the standpoint of the availability of ground water, the unconsolidated deposits in Saratoga County are divided into (1) nonstratified deposits (till), (2) coarse-grained stratified deposits (sand and gravel), and (3) fine-grained stratified deposits (silt and clay). The geologic and water-bearing characteristics of each of these are described in the section titled "Unconsolidated Deposits."

Also from the standpoint of the availability of ground water, the consolidated rocks in Saratoga County are divided into (1) crystalline rocks, (2) sandstone, (3) carbonate rocks (limestone and dolomite), and (4) shale. The geologic and water-bearing characteristics of each of these are described in the section titled "Consolidated Rocks."

The following discussions of the water-bearing characteristics of the different rock units in Saratoga County are based on records of selected water wells and test holes. These records are tabulated in table I-3. The locations of the wells are shown in figures I-5, II-4, and III-1.

Unconsolidated Deposits

Most of the veneer of unconsolidated deposits in Saratoga County was laid down by sheets of ice thousands of feet thick that invaded the area from the north several times during the last million years. The last ice sheet to cover the county may have existed as recently as 10,000 to 15,000 years ago. As the ice sheets advanced over the county they carried soil and rock debris (some of which was derived from areas considerably north of the county and some from the rocks within the county). Some of the soil and rock debris was deposited, both during the advance of the ice and during its retreat (melting), as a blanket of unsorted material called "till." This blanket of till exists today on most hills and in some lowland areas, relatively little altered by weathering or other geologic processes. In some stream valleys in the northwestern part of the county and in most of the lowlands adjacent to the Hudson and Mohawk Rivers, the blanket of till was reworked by streams carrying water derived from the melting ice sheet. The material reworked by the streams was deposited in strata (layers) in and

adjacent to the channels and in lakes into which the streams flowed. Where the stream velocities were high, predominantly large grains were deposited, forming layers referred to as a coarse-grained stratified deposit or, more simply, as sand and gravel. Where the velocities were relatively low, as in the lakes, small grains were deposited, forming layers referred to as a fine-grained stratified deposit or, more simply, as clay and silt.

A soils map of Saratoga County (Maxon, 1919) forms the basis for figure I-3, a generalized map of the unconsolidated deposits. The soils map was modified on the basis of data obtained during the well survey and after comparison with glacial maps of Stoller (1911, 1916, 1918). The deposits in the West Milton area were mapped by Simpson and Mack (Mack and others, fig. 4), and are shown in figure II-5.

Ground water occurs in unconsolidated deposits in the pore spaces between the grains. The amount of water stored in a given volume (for instance, in one cubic foot of material) depends on the porosity - or the percent of the total volume occupied by pores. Porosity depends largely on the degree of sorting and the shape of the grains composing a deposit. Thus, those parts of the sand and gravel deposits which are composed largely of rounded grains of about the same diameter have a porosity of 25 to 35 percent. On the other hand, till, which consists of a mixture of rock particles of widely different shapes and sizes, has a porosity of 5 to 15 percent.

However, the mere presence of water in the pore spaces of a deposit is no assurance that the water can be withdrawn through wells. The ability of a deposit to transmit water is termed "permeability" and is dependent on size, shape, and interconnection of the pores and other openings. Because the smaller particles in till effectively fill the openings that would otherwise exist between the larger particles, the permeability of till is relatively low. On the other hand, a uniformly grained sand and gravel deposit has a high permeability. Permeability is usually expressed quantitatively as the number of gallons a day that will flow through a square foot of material under a hydraulic gradient of 100 percent. The permeability of a well-compacted till may be as low as 0.0002 gpd/ft^2 while many sand and gravel deposits have permeabilities of more than 1,000 gpd/ft^2.

Till

Till is the principal unconsolidated deposit in the western two-thirds of the county (fig. I-3). It also underlies a large area between Saratoga Lake and the Hudson River. Small unmapped exposures of consolidated rocks occur at numerous places, particularly on the steeper hillsides in the northwestern part of the county, in the areas shown in figure I-3 as being underlain by till. Till which is locally referred to as "hardpan" consists chiefly of an unsorted mixture of rock particles ranging in diameter from less than 0.0001 inch (clay) to several feet (boulders). At places the till encloses thin lenses of well-sorted sand. The till penetrated by wells listed in table I-3 ranges in thickness from zero at bedrock outcrops to about 70 feet in well Sa 243. Well Sa 1028T penetrated till from the surface to a depth of 65 feet and from 160 feet to 218 feet. The till was separated between depths of 65 and 160 feet by clay and sand.

Because of the low permeability of till, water in quantities adequate for household needs can be obtained only from large-diameter wells. Normally wells drawing from till are dug with hand tools and are finished with a curbing of stone laid with open joints. The average depth of the 98 dug wells listed in table I-3 that draw water from till, is 17 feet. These wells range in depth from 5 to 70 feet (table I-1). The large diameter of such wells provides a large area through which water can percolate into the well and a large volume for the storage of water between periods of use. The yields of dug wells vary widely. The more productive wells probably derive water largely from thin sand lenses in the till. Most wells drawing from till will yield only a few hundred gallons of water a day. The yield of many wells in till declines drastically during the late summer and early fall owing to the seasonal decline of the water table. During those summers when precipitation is deficient many wells in till go dry entirely. Deepening such wells would, in many cases, provide sufficient water to see the owner through the dry period. The only solution in other cases is to develop an additional source of supply (for example, by constructing a drilled well into the underlying consolidated rock).

Table I-1.--Depths of water wells

Water-bearing material	Common type of well	Depth (feet)			Number of wells
		Average	Shallowest	Deepest	
Till	Dug	17	5	70	98
Sand	Driven	20	6	31	36
Sand and gravel	Drilled	80	17	145	25
Bedrock	Drilled	176	23	675	62

Sand and Gravel

Stratified deposits of sand and gravel underlie large areas in the eastern part of the county. They also underlie parts of the stream valleys in other parts of the county (fig. I-3). These deposits are predominantly a fine to coarse sand. However, in places, particularly in the lower part of the deposit in the Hudson lowland and in some stream valleys, layers of fine to coarse gravel are present. Sieve analyses showing the percent distribution of particles of various sizes are shown in figures II-6 and III-7. The sand and gravel is underlain in most of the eastern part of the county by clay. (See the following discussion of clay and silt.) In the remainder of the county the coarse-grained stratified deposits probably are underlain principally by till although in some areas they may rest directly on bedrock.

In parts of the Hudson lowland sand and gravel underlies the clay and silt as shown by the section exposed in a sand and gravel pit a few hundred feet west of U. S. Highway 4, 2 miles north of Stillwater (fig. III-1). A geologic section of the pit is given in the discussion entitled "Sand and Gravel" in Part III. The sand and gravel deposit underlying the clay is not believed to be extensive. Therefore, unless otherwise indicated, the sand and gravel deposits described here and shown in figure I-3 are the sand and

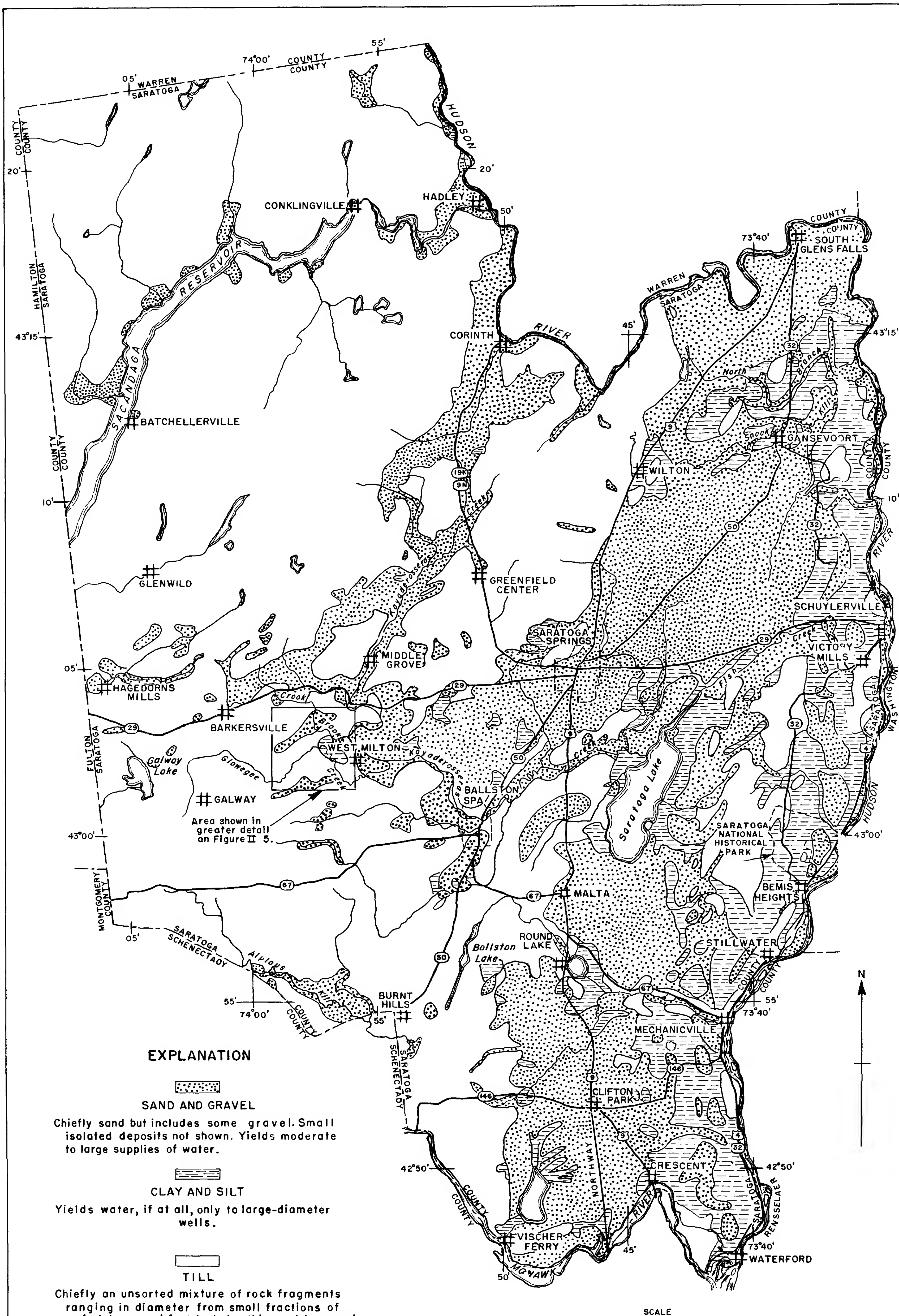

Figure I-3.--Map of Saratoga County showing principal types of unconsolidated deposits.

gravel deposits which are exposed at the present land surface and which may be appropriately termed "surficial deposits."

The thickest section of sand and gravel known to have been penetrated in the county is 120 feet in well Sa 506. In most places the deposit is less than 50 feet thick; the average thickness is probably about 25 feet.

The sand and gravel is the most productive source of ground water in the county. Where the deposit consists chiefly of sand, supplies of water adequate for domestic needs can generally be obtained from driven wells as small as $1\frac{1}{4}$ inches in diameter and equipped with a screened drive point. Such wells, properly developed, will yield from 5 to 10 gpm (gallons per minute) or more. Larger diameter wells will yield proportionately more water. The average depth of 36 driven wells listed in table I-3 is 20 feet. These wells range in depth from 6 to 31 feet (table I-1). (Additional discussion of the water-bearing characteristics of the surficial sand deposit that underlies the eastern part of the county is contained in Part III.)

Where the deposit contains layers of gravel, supplies of several hundred gallons per minute can be obtained from properly developed drilled wells. The average depth of 25 drilled wells drawing from sand and gravel deposits (table I-3) is 80 feet and range in depth is from 17 feet to 145 feet (table I-1). (See the discussion of the stratified deposits underlying the valley of Kayaderosseras Creek in Part II.)

The development of water supplies from the coarser-grained stratified deposits in much of the lowland adjacent to the Hudson River presents certain problems, because the deposits consist largely of thin layers of coarse to medium sand alternating with layers of silt and fine sand. Chief among these problems is the development required to obtain the maximum yield. In the process of driving a well the screen is enveloped in a mixture of material ranging in grain size from silt to coarse sand. As this mixture is relatively impermeable the yield of the well when first driven is rather low, in some cases only a fraction of a gallon per minute. The yield of the well can generally be increased substantially by alternately pumping water into the well under high pressure and pumping water from the well to remove fine material from the area surrounding the screen. The procedure used to develop test wells drilled in the Saratoga National Historical Park is described in Part III.

Clay and Silt

Fine-grained stratified deposits consisting chiefly of clay but also containing some silt underlie relatively extensive areas in the eastern part of the county (fig. I-3). These deposits were laid down in lakes that occupied the area in the closing stages of the "ice age." In figure II-4 they are referred to as "lake-bottom deposits." These deposits almost invariably underlie the surficial layer of sand and gravel and thus are exposed in many places where the overlying sand and gravel has been removed by erosion. In addition, the clay and silt underlies areas, such as that in the western part of the Saratoga National Historical Park, which appear never to have been covered by sand or sand and gravel. In most places the clay and silt rests directly on till or on bedrock. In other places, probably of small extent, the clay and silt is underlain by sand and gravel.

The clay and silt is, for all practical purposes, impermeable and thus will not yield water in usable quantities. In a few places wells have been dug through several feet of sand and into the underlying clay to depths of 5 to 10 feet (well Sa 21). Most of the water drawn from such wells doubtless is derived from a thin saturated zone in the lower part of the sand. The hole in the clay serves primarily as a reservoir between periods of use.

From the standpoint of ground water the clay serves as an impermeable bottom for the overlying sand and gravel. It also serves as an impermeable cover for the underlying deposits. As a result, the water in the underlying deposits occurs under artesian conditions. This does not mean that wells drilled through the clay and into the underlying till or bedrock will flow at the surface. According to the current definition, water under artesian conditions need only rise to a level above the bottom of the clay (the confining bed). However, in some of the lower areas, for instance along parts of the valleys of the small streams flowing into the Hudson River, water from wells drilled into water-bearing deposits beneath the clay will flow at the surface.

Consolidated Rocks

The consolidated rocks underlying the unconsolidated deposits in Saratoga County are divided on the basis of type of opening and mineral composition into (1) crystalline rocks, (2) sandstone, (3) carbonate rocks, and (4) shale. It may be noted that this subdivision is also consistent from the standpoint of age, the crystalline rocks being the oldest and the shale being the youngest. In contrast to the unconsolidated deposits, none of which are more than 1 million years old and most of which are probably only 10,000 to 15,000 years old, the age of the consolidated rocks is almost beyond comprehension. The oldest, the crystalline rocks, are of Precambrian age and thus, are at least 510 million years old and may be much older. The youngest consolidated rocks, the shales, are of Ordovician age and, thus, are at least 350 million years old. The areas underlain by the different types of consolidated rocks are shown in figure 1-4.

Ground water occurs in the consolidated rocks in a completely different type of opening from that present in the unconsolidated deposits. In the consolidated rocks pore spaces are either completely absent or, if present, are not interconnected and, thus, do not contribute to any significant extent in the storage and movement of water. Ground water occurs in the consolidated rocks in three different types of openings. These are (1) faults, (2) joints, and (3) bedding planes. Faults are breaks along which the rocks on the two sides have been displaced relative to each other. Faults are relatively abundant in Saratoga County and at most places form the contact between the rock units shown in figure 1-4. Other faults occur within the same rock unit. Along most of the faults the rocks to the southeast were displaced downward relative to the rocks to the northwest. The amount of the displacement varies at different places along the same fault and from fault to fault. However, displacements of a few hundred feet are not uncommon. One of the consequences of faulting from the standpoint of ground water is that deep wells only a few hundred feet apart may penetrate entirely different types of rock. In places along faults, the rocks may be so shattered that wells penetrating these zones will have substantially greater yields than wells penetrating other parts of the bedrock.

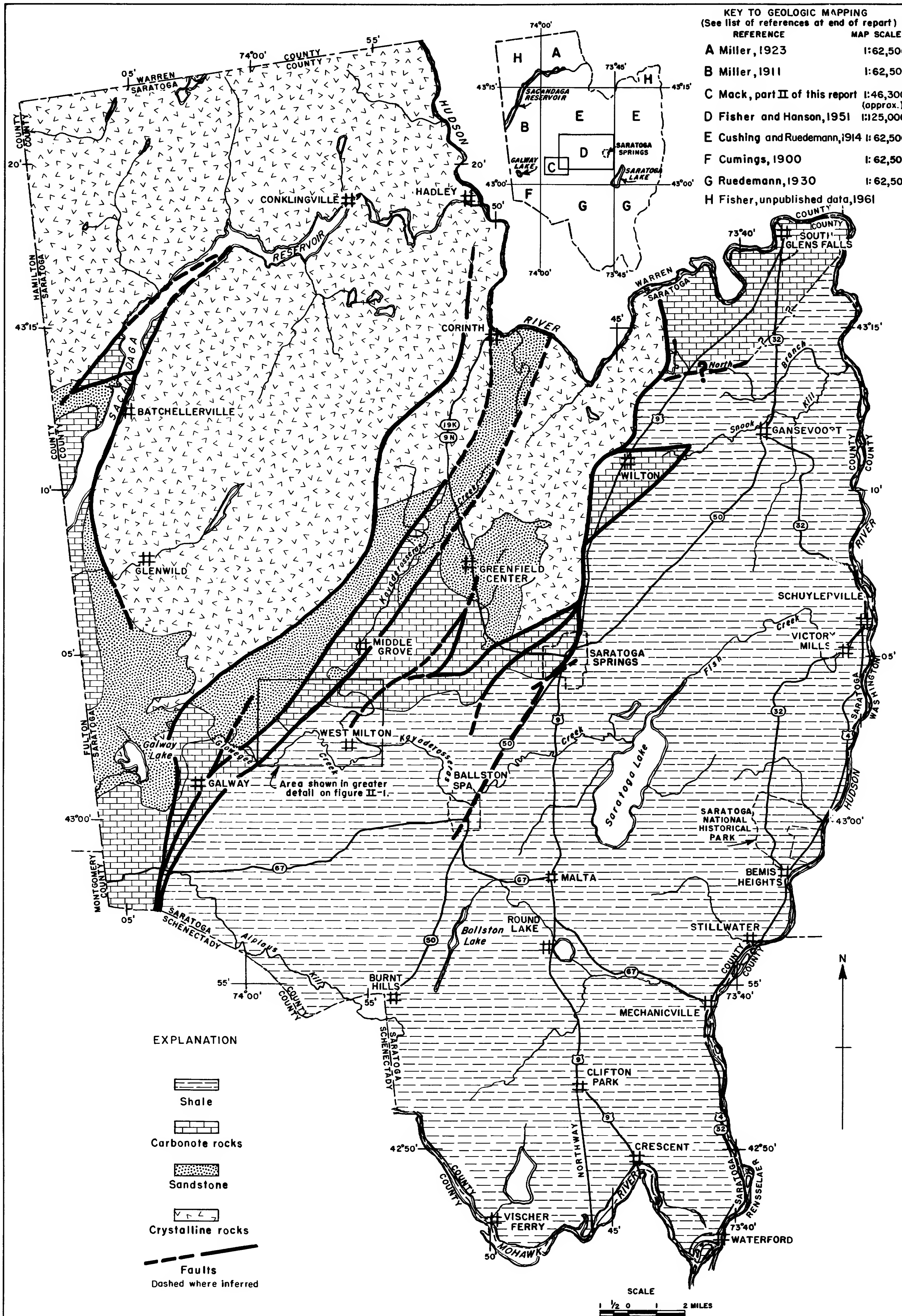

Figure I-4.--Map of Saratoga County showing distribution of consolidated rocks.

Joints are breaks (fractures) in the consolidated rocks along which no displacement has occurred. The spacing of joints ranges from several inches to many feet. The joints trend in various directions and dip at steep angles. Although the openings along joints are generally minute they, nevertheless, play a significant role in the yield of wells drawing from the consolidated rocks. The opening developed along a joint is generally largest near the top of the rock. The size of the opening decreases with depth and in most rocks probably becomes insignificatn at depths of 200 to 300 feet. Drilling below those depths will not increase the yield of the well in most cases.

Bedding planes, as the name implies, are planes which separate individual layers or beds. Obviously, such planes exist only in a layered (stratified) rock. Thus, they occur in the sandstone, carbonate rocks, and shale units shown in figure I-4 but not in the crystalline rocks. The beds, and thus the bedding planes, in the sandstone, carbonate rocks, and in the shale in the south-central part of the county dip at low angles away from the crystalline rocks except where the dip of the beds has been affected by faulting. In the eastern part of the county, on the other hand, the beds comprising the shale are tightly folded. Throughout a large part of the area the folds are overturned toward the west. As a result, the bedding planes generally dip toward the east at rather steep angles (Cushing and Ruedemann, 1914, p. 102). From the standpoint of ground water, openings developed along bedding planes play an important role in the movement of water.

Crystalline Rocks

Crystalline rocks directly underlie the unconsolidated deposits in most of the northwestern part of the county and in a large area in the north-central part, north of the city of Saratoga Springs (fig. I-4). In the remainder of the county they underlie the younger consolidated rocks. The crystalline rocks are composed of several different types of metamorphic and igneous rocks. The metamorphic rocks include schist, quartzite, gneiss, and limestone (marble). The igneous rocks include granite, anorthosite, syenite, and gabbro. In most places the metamorphic and igneous rocks are intimately intermingled.

Water is obtained from the crystalline rocks from drilled wells that penetrate them to depths of 150 to 200 feet. The depth of 62 of the drilled wells in bedrock listed in table I-3 averages 176 feet and ranges from 23 feet to 675 feet (table I-1). Wells drawing from crystalline rocks, as well as from the other bedrock units, are generally cased to the top of rock and left uncased from the top of rock to the bottom of the well. The yield of these wells depends on the number and size of the joints and other openings penetrated. Yields were reported for nine of the wells drawing from crystalline rocks listed in table I-3. The yield of these ranged from 1 to 20 gpm and averaged about 5 gpm (table I-2).

Sandstone

The crystalline rocks are partly bordered (fig. I-4) by a rock consisting largely of sandstone but containing, in the upper part, interbedded layers of dolomite. The rocks here referred to as "sandstone" include the

Potsdam Sandstone and Theresa Dolomite (Cushing and Ruedemann, 1914). The thickness of the unit is rather irregular but is believed to range from about 200 feet to about 400 feet. The sandstone overlies crystalline rocks and is in turn overlain by carbonate rocks.

Yields are reported for 12 of the wells drawing from sandstone listed in table I-3. The yield of these wells ranges from 2 to 100 gpm and averages about 20 gpm (table I-2).

Table I-2.--Yield of wells in bedrock

Water-bearing formation	Yield (gpm) Average	Range Low	Range High	Number of wells
Shale	10	0.5	80	110
Carbonate rocks	30	1	300	25
Sandstone	20	2	100	12
Crystalline rocks	5	1	20	9
All bedrock combined	14	0.5	300	156

Carbonate Rocks

A series of carbonate rocks partially border the sandstone rocks on the south and, where the sandstone rocks are absent, they border the crystalline rocks (fig. I-4). The carbonate rocks consist largely of dolomite although parts of the series are composed of limestone. These rocks have been subdivided into several formations on the basis of differences in geologic age and composition. The formation names applied to the rocks, from the oldest to the youngest, are Hoyt Limestone, Little Falls Dolomite, (Gailor Dolomite of Fisher and Hanson, 1951), Amsterdam Limestone, and Glens Falls Limestone. All of these formations are not present every place in the area indicated in figure I-4 as being underlain by carbonate rocks. In much of the area of outcrop the younger beds have been removed by erosion. The presence of numerous faults and other factors makes determination of thicknesses difficult. The unit is probably 300 to 400 feet thick in most places and possibly as much as 700 feet thick at some places. The carbonate rocks overlie the sandstone and are overlain in turn by shale.

Yields are reported for 25 of the wells drawing from carbonate rocks listed in table I-3. The yield of these wells ranges from 1 to 300 gpm and averages about 30 gpm (table I-2).

No discussion of the occurrence of ground water in Saratoga County would be complete without mentioning the highly mineralized water that made Saratoga Springs and Ballston Spa famous. The "mineral" water is discussed in considerable detail by Kemp (1912). The water occurs principally in the Gailor Dolomite of Fisher and Hanson (1951) and apparently originates in the eastern part of Saratoga County and also possibly in the western part of Washington

and Rensselaer Counties. The water at Saratoga Springs appears to be controlled by the Saratoga fault. East of the fault the dolomite is overlain by shale which prevents upward seepage of the water. Movement of water across the fault is prevented by the presence of impermeable crystalline rocks which lie opposite the Gailor Dolomite of Fisher and Hanson (1951) on the west side of the fault. The origin of the water is not known. However, the presence of abundant carbon dioxide and the high concentration of chloride, bromide, iodide, fluoride, and sodium carbonate suggest an igneous origin (Kemp, 1912, p. 48-64).

Shale

Most of the eastern and southern parts of the county (fig. I-4) are underlain by a thick section of consolidated rocks consisting largely of shale interbedded with thin layers of sandstone. These rocks have been subdivided into the following formations: Normanskill Shale, Snake Hill Formation, Canajoharie Shale, and Schenectady Formation. The thickness of the shale ranges from a few hundred feet near the contact with the limestone to considerably more than 1,000 feet in the southern part of the county.

Yields are reported for 110 of the wells drawing from shale listed in table I-3. The yield of these wells ranges from 0.5 to 80 gpm and averages about 10 gpm (table I-2).

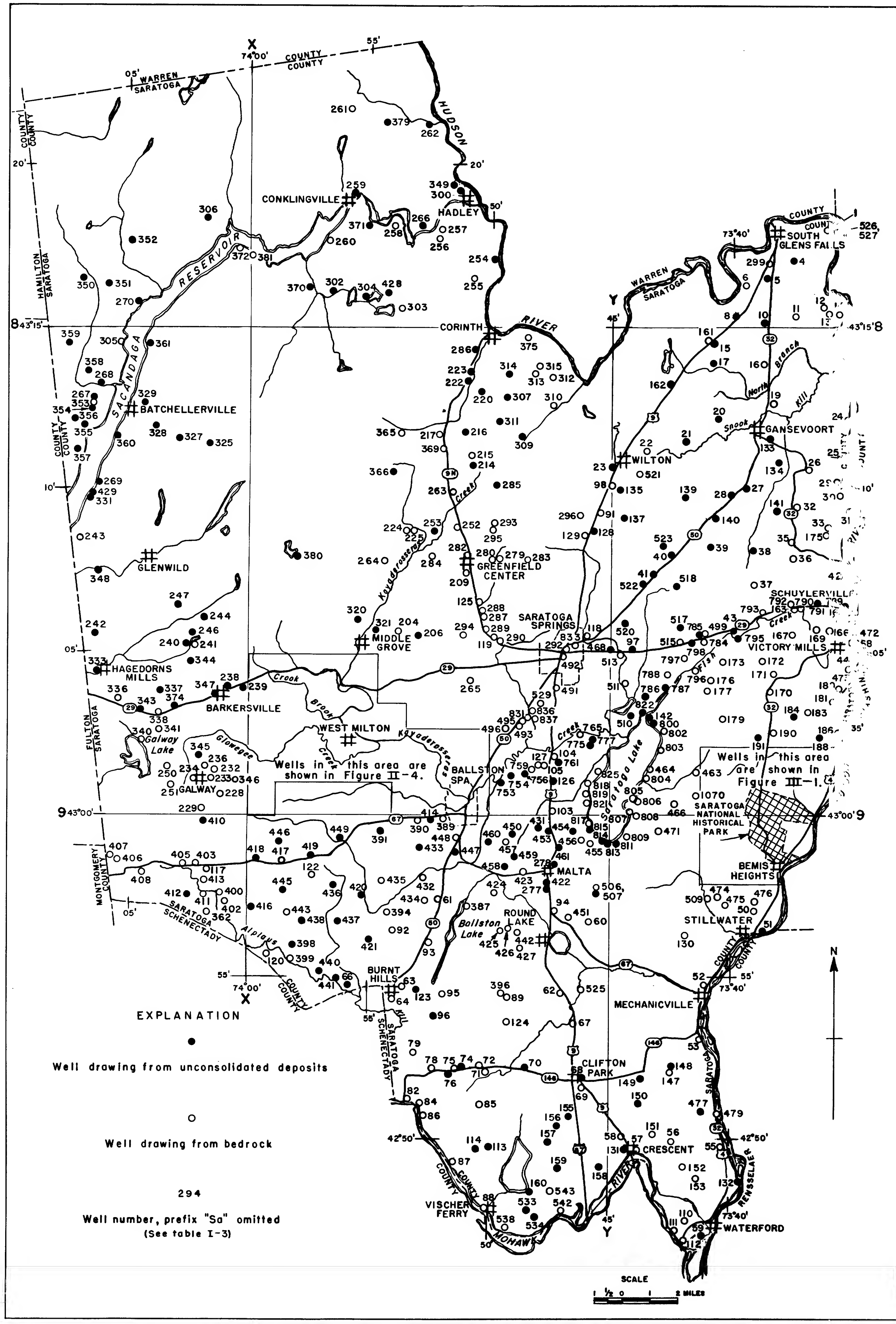

Figure I-5.--Map of Saratoga County showing the location of selected wells and test holes.

Table 1-3.--Records of selected wells and test holes in Saratoga County

Location: For explanation of location coordinates see section entitled "Well-Location System".

Altitude: Where determined by spirit leveling, the altitude is given to the nearest tenth of a foot. Others estimated from topographic maps.

Type of well: Brd, bored; Drl, drilled; Drv, driven; J, jetted.

Water level: Measurements made by the U. S. Geological Survey are given to nearest tenth of a foot. Other water levels are reported by the owner or driller. Plus (+), indicates water level is above land surface.

Yield: Where measured, yields are given to nearest tenth of a gallon. Others are reported.

Use: A, agricultural; C, commercial; D, domestic; I, industrial; O, observation; P, public supply; S, stock; T, test well; U, unused.

Remarks: (a), chemical analysis in table II-2; (b), chemical analysis in table III-1; gpm, gallons per minute; ppm, parts per million. Figures following formations penetrated are given in feet.

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 1	8Y, 3.6N, 7.3E	C. Culver	1940	300	Drl	176	6	7	Carbonate rock	--	5	O	Clay 0-7, limestone 7-176.
Sa 4	8Y, 2.5N, 6.3E	Leo Lemery	1934	350	Drv	29	1½	--	Sand	12	--	D	Well driven in cellar 5 ft below land surface.
Sa 5	8Y, 1.7N, 5.5E	Raymond Jacobie, Sr.	1915	350	Drv	26	1½	--	do.	10	2	D,S	
Sa 6	8Y, 1.6N, 4.6E	John Nolan	1943	350	Drl	270	6	154	Carbonate rock	65	10	--	Sand and boulders 0-154, limestone 154-270.
Sa 8	8Y, 0.4N, 4.2E	Harvey Garlitz	1946	350	Drv	39	1½	--	Sand and gravel	--	--	O	
Sa 10	8Y, 0.1N, 5.4E	Isaac Stevens	1937	320	Drv	18	1½	--	Sand	9	--	D,S	Well driven in cellar 6 ft below land surface.
Sa 11	8Y, 0.5N, 6.3E	L. Ross	1945	260	Drl	191	6	60	Carbonate rock	10	4	--	Sand 0-20, clay 20-60, limestone 60-191; main water-bearing zones at 120 and 185.
Sa 12	8Y, 0.7N, 7.4E	Benjamin Kirby	1934	220	Drl	158	6	79	Shale	48	2	D,S	Clay 0-79, shale 79-158.
Sa 13	8Y, 0.5N, 7.6E	M. J. O'Connor	1934	220	Drl	116	6	22	do.	22	6	--	Clay 0-?, till ?-22, shale 22-116. Well yielded 3 gpm at 60 ft.
Sa 14	8Y, 0.6N, 7.9E	Reuben J. Taylor	1934	200	Drl	92	6	26	do.	8	6	O,S	Sand and clay 0-?, till ?-26, shale 26-92.
Sa 15	8Y, 0.5S, 3.5E	C. L. Craig	1940	350	Drv	35	1¼	--	Sand	--	--	O,C	Well driven in cellar 5 ft below land surface.
Sa 16	8Y, 1.2S, 5.3E	William Dorvee	1944	280	Drl	101	6	12	Shale	12	2	D,S	Sand 0-12, shale 12-101.
Sa 17	8Y, 1.5S, 3.5E	Kenneth Bradley	1885±	280	Dug	22	36	--	Sand	8	--	D	
Sa 19	8Y, 2.7S, 5.6E	Charles Baker	1940	240	Drl	190	8	66	Shale	21	5	D	Sand 0-?, till ?-66, shale 66-190.
Sa 20	8Y, 3.3S, 3.7E	G. Buell	--	260	Drv	16	1½	--	Sand	10	--	S	
Sa 21	8Y, 4.1S, 2.5E	Primeau & Bartlett	1850±	300	Dug	15	36	--	do.	10	--	S	Sand 0-8, clay 8-15.
Sa 22	8Y, 4.4S, 1.2E	Frank Miller	1930	320	Drl	101	6	28	Shale (?)	10	--	S	Clay 0-28, shale (?) 28-101.
Sa 23	8Y, 4.8S, 0.1E	S. Giuro	1934	350	Drl	52	6	52	Gravel	--	4	C	Clay 0-? and till ?-48, gravel 48-52.
Sa 24	8Y, 3.4S, 8.3E	Linendoll Bros.	1890	120	Dug	12	48	--	Till	6	--	D,S	Clay 0-3, till 3-12.
Sa 25	8Y, 4.7S, 8.3E	Mrs. A. Hillman	1895	120	Dug	18	36	--	Sand	12	--	D	Sand 0-18.
Sa 26	8Y, 5.0S, 6.8E	John Peters, Sr.	1940	260	Drl	144	8	11	Shale	11	15	O,S	Till 0-11, shale 11-144.
Sa 27	8Y, 5.7S, 4.5E	Arthur Smith	1937	260	Drv	21	1¼	--	Sand	15	--	O,S	Well driven in cellar 7 ft below land surface.
Sa 28	8Y, 5.9S, 4.2E	G. W. Scott	1933	280	Drv	42	1¼	--	Gravel	17	--	D	Do.
Sa 29	8Y, 5.5S, 7.7E	A. Solomon	1944	180	Drl	125	6	3	Shale	+1	10	--	Clay 0-3, shale 3-125. Well flows.
Sa 30	8Y, 5.9S, 8.0E	Donald Corlew	1930	130	Drl	180	3	100?	do.	--	--	--	Clay 0-100?, shale 100?-180. Water contains hydrogen sulfide.
Sa 31	8Y, 6.5S, 8.3E	John J. Harris	1913	160	Drl	200	6	74	do.	--	--	--	Well reportedly dry.
Sa 32	8Y, 5.4S, 6.3E	A. C. Barber	1939	290	Drl	105	6	58	do.	40	8	D,S	Sand 0-?, till ?-58, shale 58-105. Water contains hydrogen sulfide.
Sa 33	8Y, 7.1S, 7.5E	Willard H. Peck	1900	230	Drl	85	6	45	do.	20	--	S	Clay 0-45, shale 45-85. Water contains hydrogen sulfide.

Table 1-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 35	8Y, 7.6S, 6.3E	Albert Cook	1941	300	Drl	128	6	28	Shale	19	4	--	Till 0-28, shale 28-128. Drawdown 81 ft after pumping 4 gpm for 15 min.
Sa 36	8Y, 8.2S, 6.3E	Edgar King	1915	320	Drl	165	8	--	do.	18	--	D	
Sa 37	8Y, 9.0S, 5.0E	King Bros. Dairy	1940	300	Drl	166	8	63	do.	20	3	C	Sand 0-?, till ?-63, shale 63-166.
Sa 38	8Y, 7.9S, 4.9E	do.	1875	260	Dug	20	30-60	--	Sand	15	--	D,S	Sand 0-20. Water contains some hydrogen sulfide.
Sa 39	8Y, 7.8S, 3.4E	R. Berghamer	1943	330	Drv	23	1¼	--	do.	17	--	D	Well driven in cellar 6 ft below land surface.
Sa 40	8Y, 8.1S, 2.1E	Mrs. Rose Zwijacz	1921	320	Dug	14	48	--	do.	8	--	D	
Sa 41	8Y, 8.7S, 1.4E	Paul Yurick	1929	310	Dug	17	48	--	do.	13	--	C	
Sa 42	8Y, 9.8S, 8.2E	Harry Saney	1942	120	Drl	100	8	5	Shale	10	2	D	Sand 0-5, shale 5-100. Drawdown 85 ft after pumping 2 gpm for 30 min.
Sa 43	8Y, 10.6S, 4.4E	C. Christensen	1931	210	Dug	18	30	--	Sand	13	--	D	
Sa 44	8Y, 12.0S, 8.3E	George Gay	1942	120	Drl	64	6	30	Shale	--	1	--	Clay 0-30, shale 30-64.
Sa 45	9Y, 1.8N, 5.8E	Henry Schultz	--	290	Drl	140	6	100	do.	20	3	D	Well originally drilled to depth of 100 ft. Yield inadequate. Deepened to 140 ft in 1939.
Sa 46	9Y, 2.5N, 5.2E	Frederick H. Dodd	1942	320	Drl	102	8	16	do.	--	4	D,S	Drawdown 40 ft after pumping 4 gpm for 20 min.
Sa 47	9Y, 2.0N, 3.4E	S. W. Baker	1942	500	Drl	66	8	15	do.	20	5	S	Till 0-15, shale 15-66. Drawdown 30 ft after pumping 5-6 gpm for 15 min.
Sa 48	9Y, 0.9S, 4.8E	Edward Gilligan	1942	310	Drl	64	6	3	do.	--	--	--	
Sa 50	9Y, 3.4S, 5.1E	John Anusesky	1943	140	Drl	87	6	0	do.	13	--	S	
Sa 51	9Y, 4.1S, 5.4E	Village of Stillwater	1935	80	Drl	24	12	--	Gravel	15	--	P	Water contains hydrogen sulfide and 2.3 ppm iron. Treated with iron and aerated before distribution.
Sa 52	9Y, 6.1S, 3.5E	West Virginia Pulp & Paper Co.	1916	80	Drl	2,157	8	0	Shale	--	--	U	Shale 0-1,000, limestone 1,000-2,157. Well is abandoned.
Sa 53	9Y, 7.9S, 3.2E	Mintzer Petroleum Co.	1945	80	Drl	29	6	15	do.	4	--	I	Till 0-15, shale 15-29. Water contains hydrogen sulfide.
Sa 55	9Y, 12.1S, 4.2E	Thomas Yacano	1944	30	Drl	73	8	22	do.	16	3	C	Clay 0-?, till ?-22, shale 22-73.
Sa 56	9Y, 11.6S, 2.3E	T. Z. Ceremuga	1939	300	Drl	164	8	63	do.	30	5	D	Till 0-15, clay 15-63, shale 63-164.
Sa 57	9Y, 12.1S, 1.0E	G. Devery	1900	260	Drl	144	--	144	do.	--	--	--	Clay, marl, boulders 0-144, shale at 144.
Sa 58	9Y, 11.4S, 0.6E	F. C. VanDenburgh	1939	260	Drl	182	8	19	do.	8	8	D	
Sa 59	9Y, 15.0S, 3.4E	Cluett Peabody Co., Inc.	--	50	Drv	21	1¼	--	Sand and gravel	18	--	D	Sand and gravel 0-21.
Sa 60	9X, 3.8S, 12.0E	Robert Griffen	1940	250	Drl	160	6	69	Shale	34	3	D,S	Sand 0-?, till ?-69, shale 69-160. Drawdown 116 ft after pumping 3-4 gpm for 15 min.
Sa 61	9X, 3.0S, 6.8E	Milford Playford	1940	400	Drl	85	8	18	do.	3	3	--	Till 0-18, shale 18-85.
Sa 62	9X, 6.4S, 11.2E	Joseph P. Dube	1940	210	Drl	106	6	36	do.	22	2	D,C	Till 0-36, shale 36-106.
Sa 63	9X, 6.2S, 5.5E	Harold S. Laws	1942	400	Drl	195	8	35	do.	40	3	--	Till 0-35, shale 35-195.
Sa 64	9X, 6.6S, 5.2E	F. J. Taylor	1937	390	Drl	102	6	52	do.	--	4	D	Till 0-49, shale 49-102.
Sa 66	9X, 6.1S, 3.7E	W. C. Dole & O. J. Rector	--	380	Drl	62	6	--	Gravel	--	5	--	Coarse gravel 0-62.
Sa 67	9X, 7.5S, 11.6E	Unknown	--	260	Drl	125	6?	120	Shale	--	10	--	Coarse gravel and boulders 0-40, gray hard clay 40-60, till 60-90, gray sand 90-120, shale 120-125.

Table I-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date com-ple-ted	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 68	9X, 9.3S, 11.7E	W. G. Thiele	1945	350	Dug	28	36	--	Sand and gravel	17.6 8/27/45	--	O	Fine gravel and coarse sand 0-28.
Sa 69	9X, 9.4S, 11.7E	Unknown	--	350	Drl	90	6?	80	Shale	--	5	--	Sandy gravel 0-30, clayey gravel 30-80, shale at 80.
Sa 70	9X, 9.0S, 9.7E	Lawrence Peck	--	310	Drl	65	6?	--	Gravel	--	15	--	Sandy gravel 0-20, clayey gravel 20-65.
Sa 71	9X, 9.0S, 8.4E	Glen Beck	--	370	Drl	42	6?	40	Shale	--	8	--	Till 0-40, shale 40-42. Water contains hydrogen sulfide.
Sa 72	9X, 9.0S, 8.2E	C. A. Beck	1931	360	Drl	504	8	53	do.	18	--	--	Till 0-53, shale 53-504. Yield less than 1 gpm. Well is abandoned.
Sa 74	9X, 9.0S, 7.5E	Oliver Waite	1943	340	Drl	33	6	--	Gravel	3	30	O	Yellow and blue clay 0-32, gravel 32-33+. Water contains hydrogen sulfide.
Sa 75	9X, 9.0S, 7.4E	Althea Washington	1941	340	Drl	228	8	43	Shale	33	.5	--	Till 0-43, shale 43-228. Well is abandoned.
Sa 76	9X, 9.1S, 7.2E	Carl Eichenburger	1938	360	Drl	56	6	56	Gravel	9.1 8/27/45	7	O	Blue clay 3-?, black muck ?-?, gravel ?-56. Well drilled in cellar 3 ft below land surface.
Sa 78	9X, 9.0S, 6.8E	L. DeLong	--	360	Dug	15	48	12	Shale	--	--	--	
Sa 79	9X, 8.5S, 6.0E	George Tibbits	1940	370	Drl	83	8	18	do.	16	2	--	Till 0-18, shale 18-83. Drawdown 64 ft after pumping 2-3 gpm for 15 min. Water contains hydrogen sulfide.
Sa 82	9X, 10.1S, 5.7E	Edward Ziobrowski	1941	260	Drl	137	8	5	do.	25	3	O	Till 0-5, shale 5-137. Drawdown 60 ft after pumping 3-4 gpm for 15 min.
Sa 84	9X, 10.1S, 6.1E	J. A. Foster	1944	330	Drl	165	8	21	do.	35	1.5	O	Till 0-21, shale 21-165. Drawdown 115 ft after pumping 1½ gpm for 20 min.
Sa 85	9X, 10.3S, 8.2E	Walter Kaminski	1942	390	Drl	105	8	20	do.	11	3	--	Till 0-20, shale (weathered) 20-30, shale 30-105. Drawdown 89 ft after pumping 3 gpm for 30 min.
Sa 86	9X, 10.7S, 6.4E	J. W. Belanger	1945	330	Drl	147	8	55	do.	23	8	--	Clay 0-?, till ?-55, shale 55-147. Drawdown 77 ft after pumping 8 gpm for 15 min.
Sa 87	9X, 12.4S, 7.3E	Glen Smith	1940	220	Drl	339	8	19	do.	35	3	O	Till 0-19, shale 19-339. Drawdown 120 ft after pumping 3-5 gpm for 15 min.
Sa 88	9X, 14.0S, 8.6E	Mrs. Buelah Sambrook	1945	210	Drl	163	8	22	do.	--	--	--	Till 0-22, shale 22-163.
Sa 89	9X, 6.5S, 9.1E	Methodist Church	--	325	Drl	500	6	90	do.	--	--	U	Sand 0-?, blue clay ?-90, shale 90-500. Insufficient yield. Well is abandoned.
Sa 91	8X, 6.5S, 12.2E	Joseph Scharer	1941	360	Drl	100	6	30	Carbonate rock	0	--	C	Sand 0-30, dolomite 30-100.
Sa 92	9X, 4.1S, 5.1E	Harold Stewart	1946	470	Drl	100	6	22	Shale	--	15	S	Main water-bearing zone between 60 and 100.
Sa 93	9X, 4.7S, 6.3E	Max Cohen	1946	410	Drl	40	6	8	do.	--	15	S,C	
Sa 94	9X, 3.5S, 10.7E	Basil Ingraham	1943	280	Drl	52	8	45	do.	24	3	O	Sand and clay 0-?, till ?-45, weathered shale 45-48, shale 48-52.
Sa 95	9X, 6.4S, 6.9E	G. R. Schauber	1902	360	Drl	60	6	--	do.	7	1	O,S	
Sa 96	9X, 7.2S, 6.6E	Lee Olesem, Jr.	1900	380	Drl	48	6	--	Gravel	--	10	O,S	Till 0-46, gravel 46-48.
Sa 97	8Y, 11.3S, 0.8E	Hall's Filling Station	1947	230	Drl	65	6	--	Sand	6	3	O,C	Sand 0-65.
Sa 98	8X, 5.4S, 12.6E	Donald Stafford	1940	360	Drl	40	6	22	Carbonate rock	36	20	C	Sand 0-22, dolomite 22-40.
Sa 103	8X, 17.1S, 10.6E	H. C. Craft	1938	260	Drl	50	6	20	Shale	19	2	U	Till 0-20, shale 20-50.
Sa 104	8X, 15.3S, 10.8E	Anthony Wandyak	1940	270	Drl	418	8	17	do.	24	8	D	Till 0-17, shale 17-418.
Sa 105	8X, 15.6S, 10.5E	Allen Wilbur	1939	260	Drl	55	6	42	do.	13	4	O,C	Till 0-42, shale 42-55.
Sa 106	9Y, 2.3S, 5.9E	E. L. Rogers	1946	100	Drl	134	6	78	do.	8	6	S	Well originally drilled to depth of 85 ft. Deepened to 134 ft in 1951.
Sa 109	9Y, 1.9S, 5.8E	Mrs. Vina Sharp	--	120	Dug	15	18	15	Gravel	5.4 4/24/58	--	U	Clay 0-?, gravel ?-15. Well is abandoned. Supply now obtained from well Sa 1037.

Table 1-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 110	9Y, 14.5S, 2.8E	John Clement	1911	140	Drl	35	6	0	Shale	--	--	--	Shale 0-35.
Sa 111	9Y, 14.9S, 2.5E	Riberdy Bros.	1912	140	Drl	87	6	12	do.	--	--	--	Till 0-12, shale 12-87.
Sa 112	9Y, 15.2S, 2.7E	Joseph Dzamba	1912	80	Drl	34	6	8	do.	--	--	U	
Sa 113	9X, 11.9S, 8.5E	Harry Ray	1850±	340	Dug	15	36	--	Till	5	--	D	
Sa 114	9X, 11.9S, 8.1E	A. Allensendrini	1850±	360	Dug	23	36	--	Sand	5	--	D	
Sa 117	9X, 1.9S, 1.3W	Doris B. Duncan	1935	720	Drl	104	6	26	Shale	flows	10	D	Till 0-26, shale 26-104. Flows from December to June.
Sa 118	8X; 11.0S, 11.6E	P. W. and C. V. Dake	1945	280	Drl	92	10	--	Carbonate rock	+2	15	C	Sand and clay 0-92. Yields mineralized water from underlying dolomite.
Sa 119	8X, 11.0S, 8.7E	R. W. and C. V. Dake	1945	340	Drl	64	10	17	Sandstone	17	100	I	Clay 0-?, till ?-17, sandstone 17-64.
Sa 120	9X, 5.0S, 0.8E	Robert Flynn	1946	500	Drl	172	6	18	Shale	18	4	D,S	Till 0-18, shale 18-172.
Sa 122	9X, 2.1S, 2.3E	H. H. Hizer	1940	540	Drl	150	6	15	do.	27	3	D,S	Till 0-15, shale 15-150.
Sa 123	9X, 6.2S, 5.9E	Burnt Hills-Ballston Lake School	--	360	Drl	27	6	--	Sand and gravel	19	20	P	Sand and gravel 0-27.
Sa 124	9X, 7.4S, 9.1E	Sarah Smith	1900±	310	Drl	200	6	172	Shale	20	--	D	
Sa 125	8X, 9.8S, 8.0E	Gilbert Cady	1945	590	Drl	30	8	9	Sandstone	10	8	D	Till 0-9, sandstone 9-30.
Sa 126	8X, 16.1S, 10.6E	Claude Burger	1946	330	Drv	33	1½	--	Sand	25	--	D	Well driven in cellar 5 ft below land surface.
Sa 127	8X, 15.5S, 10.3E	Edwin J. Ladue	1946	270	Drl	350	6	53	Shale	+4	6	D	Till 0-53, shale 53-350.
Sa 128	8X, 7.2S, 11.9E	W. R. DeGraff	1939	350	Drl	75	6	--	Sand and gravel	--	10	P	Sand 0-60, till 60-72, sand and gravel 72-75.
Sa 129	8X, 7.3S, 11.8E	J. W. Hedrick	1940	350	Drl	100	6	41	Crystalline rock	16	6	P	Sand 0-41, crystalline rock 41-100. Drawdown 69 ft after pumping 7-8 gpm for 15 min.
Sa 130	9Y, 4.3S, 2.7E	Albert Chadourne	1946	310	Drl	87	6	69	Shale	--	10	--	Yellow clay 12-69, shale 69-87. Well drilled in bottom of dug well 12 ft deep. Water contains hydrogen sulfide.
Sa 131	9Y, 12.2S, 0.9E	Howard Bell	1840	200	Dug	70?	42	--	Till	25	--	C	Clay 0-?, till ?-70.
Sa 132	9Y, 12.9S, 4.5E	Frank Wells	1920±	40	Drv	20	2	--	Sand and gravel	10	--	D	
Sa 133	8Y, 3.9S, 5.3E	Rudolph Simon	1870±	240	Dug	23	36	--	Sand	18	--	D	Sand 0-4, clay 4-23.
Sa 134	8Y, 4.8S, 5.8E	J. A. Heber	1850±	220	Dug	16	30-48	--	do.	12	--	D,S	
Sa 135	8Y, 5.7S, 0.4E	Guy Fowler	1936	340	Drl	48	6	48	Gravel	--	35	D,S	Sand and clay 0-46, gravel 46-48.
Sa 137	8Y, 6.7S, 0.5E	Clinton Craig	1927	325	Dug	14	48	--	Sand	11	--	D,S	
Sa 139	8Y, 6.0S, 2.6E	Harry Engel	1850±	300	Dug	14	24	--	do.	11	--	D,S	
Sa 140	8Y, 6.7S, 3.5E	A. C. Record	1800±	320	Dug	20	18-42	--	do.	10	--	D,S	
Sa 141	8Y, 6.5S, 5.8E	Thomas Campion	1880±	280	Dug	30	30	--	do.	--	--	D	
Sa 142	8Y, 13.8S, 1.3E	J. E. Morris	1941	200	Drl	160	6	160	Sand and gravel	4	15	D,C	Sand and gravel 0-160, shale at 160. Some ignitable gas present.
Sa 143	9Y, 0.6N, 5.7E	U. S. National Park Service	1930	250	Drl	80	6	--	Shale	flows	--	U	(b). Water flows only in winter and spring. Water contains hydrogen sulfide. Owing to periodic pollution, water is unfit for drinking.
Sa 144	9Y, 0.5N, 5.7E	do.	--	250	Dug	10	48	--	Till	3.5 4/23/58	--	U	(b).
Sa 145	9Y, 0.4N, 5.3E	do.	1840	290	Dug	17	36	--	do.	7.8 4/24/58	--	U	(b). Water-level fluctuations recorded by U. S. Geological Survey April 1958-November 1959.

Table I-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 146	9Y, 0.4N, 5.4E	U. S. National Park Service	1920	300	Drl	80	6	70	Shale	24	15	D	(b). Water is chlorinated to remove hydrogen sulfide. House supply is softened. Water leaves iron stains on fixtures.
Sa 147	9Y, 9.2S, 2.2E	H. M. Swatling	1945	240	Drl	192	6	--	do.	30	--	D,S	
Sa 148	9Y, 9.0S, 2.2E	F. Malinowski	1945	250	Drl	212	6	--	Sand and gravel	--	--	U	Clay, sand, gravel 0-212. Well is drilled in bottom of 12-ft dug well. Family draws water from dug well with hand pump.
Sa 149	9Y, 9.4S, 1.2E	J. P. Will	1850±	280	Dug	35	36	--	Sand	10	--	D	Sand 0-4, clay 4-35.
Sa 150	9Y, 10.3S, 1.2E	Alden Harris	1947	340	Dug	17	48	--	Gravel	8	--	D	Well dug in cellar 7 ft below land surface.
Sa 151	9Y, 11.4S, 1.6E	Leon Suchoski	1928	270	Drl	175	8	--	Shale	25	--	S	Water contains hydrogen sulfide.
Sa 152	9Y, 12.6S, 2.6E	A. Shulusky	1945	260	Drl	130	6	65	do.	30	--	D	Sand and clay 0-65, shale 65-130. Water contains hydrogen sulfide.
Sa 153	9Y, 12.9S, 3.1E	do.	1933	220	Drl	240	6	60	Unconsolidated sand and shale	75	50	D,S	Sand 0-60, shale 60-240.
Sa 155	9X, 11.0S, 11.4E	Anthony Pipino	1900±	320	Dug	15	36	--	Sand	7	--	D	Sand 0-3, clay 3-15.
Sa 156	9X, 11.0S, 10.9E	George Jarose	1940	300	Drv	19	1¼	--	do.	9	--	D	Well driven in cellar 4 ft below land surface.
Sa 157	9X, 11.7S, 10.6E	J. J. Hogle	1932	280	Dug	15	36	--	do.	8	--	D	
Sa 158	9X, 12.5S, 12.4E	A. C. Stiles	1850±	280	Dug	26	36	--	do.	20	--	D	
Sa 159	9X, 12.6S, 10.9E	William and Ada Knecht	1947	290	Drv	15	1½	--	do.	11	--	D	
Sa 160	9X, 13.2S, 9.9E	do.	1850±	260	Dug	20	48	--	do.	15	--	S	
Sa 161	8Y, 0.4S, 3.4E	Edward Renavo	1946	340	Drl	147	6	118	Carbonate rock	19	35	--	
Sa 162	8Y, 2.0S, 2.1E	A. Sauttar	1946	420	Drl	290	6	--	Sand	90	--	D	Sand 0-290. Sand heaved up into casing.
Sa 163	8Y, 10.1S, 6.5E	J. Larandowski	1943	210	Drl	119	6	4	Shale	--	--	S	
Sa 165	8Y, 10.2S, 7.7E	Dan Barrett	1946	300	Drl	130	6	60	do.	15	10	D	Well yielded 6 gpm at 90 ft. Water contains some hydrogen sulfide
Sa 166	8Y, 10.6S, 7.5E	Margaret Dunphy	1927	240	Drl	198±	6	30	do.	--	--	D,S	Water contains hydrogen sulfide.
Sa 167	8Y, 10.8S, 6.4E	Mrs. Mary Hamm	--	220	Drl	100	8	23	do.	20	11	D,S	Till 0-23, shale 23-100.
Sa 168	8Y, 11.1S, 8.4E	P. Germain	1930	120	Drl	85	6	54	do.	+14 flows	--	D,S	Coarse gravel 0-50, till 50-54, shale 54-85. Water contains hydrogen sulfide.
Sa 169	8Y, 10.6S, 7.2E	Ray Larmon	--	240	Drl	150	6	64	do.	17	1	D,S	Clay 0-64, shale 64-150.
Sa 170	8Y, 12.8S, 5.5E	William Smith	1946	400	Drl	40	6	3	do.	6	25	D	
Sa 171	8Y, 12.2S, 5.7E	C. W. Ketchum	1945	340	Drl	65	6	22	do.	6	--	D,S	
Sa 172	8Y, 11.7S, 5.3E	William Walsh	1946	400	Drl	125	6	17	do.	15	1	S	Till 0-17, shale 17-125.
Sa 173	8Y, 11.8S, 3.8E	C. Candido	1937	270	Drl	110	6	15	do.	25	6	D	Water contains hydrogen sulfide. 50-ft deep drilled well, 70 ft away, reached shale at 20 ft; has water level 8 ft below land surface and contains no hydrogen sulfide.
Sa 175	8Y, 7.3S, 7.5E	Henry Peck	1937	240	Drl	83	6	23	do.	7	2	D,S	
Sa 176	8Y, 12.4S, 3.5E	S. S. Peck	1895±	370	Drl	60	6	30	do.	30	--	D	
Sa 177	8Y, 12.8S, 3.4E	Edward Hanahan	1946	360	Drl	120	6	30	do.	26	--	D	
Sa 179	8Y, 13.8S, 3.9E	J. J. Shalko	--	380	Dug	28	36	13	do.	6	--	D,S	Sand 0-10, clay 10-13, black shale 13-28.
Sa 180	8Y, 12.7S, 8.0E	Kenneth Everts	1937	180	Drl	63	6	10	do.	8	35	D	

Table I-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date com-ple-ted	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 181	8Y, 13.2S, 7.8E	Kenneth Everts	1946	115	Drl	140	6	15	Shale	15	2	S	Water contains hydrogen sulfide.
Sa 183	8Y, 13.5S, 6.9E	O. R. Deming	1922	260	Drl	85	6	28	do.	20	--	S	Do.
Sa 184	8Y, 3.7S, 6.4E	F. H. Wrightman	1946	270	Drv	14	1¼	--	Sand	10	--	D	
Sa 186	8Y, 14.3S, 7.9E	John Doyle	1946	180	Drl	455	8	200	Shale	120	1	D	
Sa 188	8Y, 14.5S, 7.3E	Charles Carden	1945	240	Drv	10	1¼	--	Sand	6	--	D,S	
Sa 190	8Y, 14.2S, 5.5E	A. H. Velders	1939	320	Drl	83	8	11	Shale	7	40	D,S	Yielded 36 gpm at 44 ft.
Sa 191	8Y, 14.5S, 5.2E	Mrs. Frank Goggin	1936	340	Dug	11	36	--	Till	2	--	D	
Sa 193	9Y, 2.4N, 6.2E	John Cichacki	1946	260	Drl	234	6	125	Shale	174	5	S	Sand and clay 0-125, shale 125-234. Water contains hydrogen sulfide.
Sa 194	9Y, 0.7N, 7.6E	Fred Kusslus	1941	90	Drv	21	1¼	--	Sand and gravel	9	--	D	
Sa 195	9Y, 0.8N, 6.6E	Raymond Phillips	1947	220	Drv	18	1¼	--	Sand	--	--	D	Pumped sand with 80-gauze screen. 60-gauze screen now installed.
Sa 197	9Y, 1.5N, 6.0E	E. C. Hanna	1932	270	Drl	99	6	20	Shale	13.3 7/15/58	--	U	Well drilled in bottom of 16-ft dug well. Family hauls water from Dakota Spring (Sa 48Sp).
Sa 198	9Y, 1.5N, 5.1E	Mrs. Ralph Durkee	1946	380	Drl	118	6	15	do.	--	3	S	Water contains hydrogen sulfide.
Sa 199	9Y, 1.8N, 5.1E	E. R. Bentley	1946	360	Drl	79	6	17	do.	9	5	S	Do.
Sa 200	9Y, 2.0N, 4.4E	J. F. Thomas	1945	360	Drl	36	6	3	do.	8	20	D,S	Do.
Sa 201	9X, 1.8N, 6.2E	Reed Greinert	--	440	Dug	12	--	12	Sand	--	--	D,S,C	Supplies 50 head of livestock.
Sa 202	9X, 2.3N, 4.7E	Jennie Pullen	--	410	Drv	29	--	--	do.	18	--	--	
Sa 203	9X, 4.9N, 3.3E	Boy Scouts of America, Schenectady Council	1937	510	Drl	169	6	--	Sand and gravel	31	--	P	Driller reports drawdown small when yield was tested by bailing. Supplies most of water used at boy scout camp.
Sa 204	8X, 10.8S, 5.3E	C. W. Mattison	--	630	Drl	53	6	13	Carbonate rock	25	--	D	
Sa 206	8X, 10.8S, 6.0E	Arthur Bumstead	1946	620	Drl	65	6	--	Sand and gravel	15	15	D	
Sa 207	9X, 5.0N, 3.4E	Boy Scouts of America, Schenectady Council	1930	530	Drl	42	6	17	Carbonate rock	Flows	1	P	Temp 47°F, 11/20/56. Serves as an auxiliary well.
Sa 208	9X, 4.1N, 4.2E	Roger Stephenson	--	440	Drl	44	6	5	do.	--	--	D	Temp 48°F, 12/3/46.
Sa 209	8X, 8.7S, 7.7E	Greenfield Grange No. 807	1937	670	Drl	39	6	30	Sandstone	13	8	D	Till 0-30, sandstone 30-39.
Sa 214	8X, 5.0S, 7.8E	Mrs. Carrie Carey	--	660	Dug	20	--	--	Till	16	--	D	
Sa 215	8S, 4.6S, 7.7E	William Atwell	--	670	Dug	16	--	11	Carbonate rock	8	--	D	Sand 0-11, dolomite 11-16.
Sa 216	8X, 3.8S, 7.4E	C. Chandler	1946	650	Dug	16	--	--	Till	8	--	--	
Sa 217	8X, 3.8S, 6.4E	Fred Oakes	--	700	Drl	58	6	30	Crystalline rock	16	--	D	
Sa 220	8X, 2.2S, 8.0E	Joseph Nado	--	660	Drl	92	6	--	Gravel	42	--	D	Sand, till, gravel 0-92.
Sa 222	8X, 1.8S, 7.4E	G. D. Flora	--	640	Drv	37	--	--	Sand and gravel	--	--	D	Till 0-23, sand and gravel 23-37.
66wsi Sa 223	8X, 1.6S, 7.5E	Harold Martin	--	640	Drl	56	6	--	do.	40	--	D	Sand and gravel 0-56.
Sa 224	8X, 7.1S, 5.8E	H. J. Winne	--	670	Drl	61	6	24	Carbonate rock	--	--	D	Till 0-24, dolomite 24-61. Yields less than 1 gpm.
Sa 225	8X, 7.1S, 5.9E	Joseph Doherty	--	660	Drl	90	6	18	do.	20	5	D	
Sa 228	8X, 16.6S, 0.9W	James G. Donnan	1939	860	Drl	85	8	21	Shale	3	3	D,S	Till 0-21, shale 21-85.

Table I-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date com-ple-ted	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 229	8X, 17.0S, 1.5W	H. L. Shuttleworth	1939	910	Drl	97	8	7	Carbonate rock	7	3	D	
Sa 232	8X, 15.9S, 1.0W	T. Naykow	1934	830	Drl	41	8	5	do.	9	2	D	
Sa 233	8X, 16.0S, 1.4W	Miss Elizabeth Donnan	1936	840	Drl	50	8	11	do.	19	10	D	
Sa 234	8X, 16.0S, 1.8W	Edward G. Davey	1938	830	Drl	63	6	9	do.	5	10	D	
Sa 236	8X, 15.6S, 1.5W	Richard Wright	1934	810	Drl	53	6	12	do.	18	30	D	
Sa 238	8X, 12.8S, 1.0W	Ray Brome	--	940	Drl	100	6	--	Gravel	40	--	D,S	Till 0-65, gravel 65-100.
Sa 239	8X, 11.8S, 0.1W	Julius Kaplinowski	--	920	Drl	85	6	--	Sand and gravel	20	--	D,S	
Sa 240	8X, 11.0S, 2.0W	B. C. Packer	1933	1,140	Drl	30	6	--	do.	12	15	D	Sand and gravel 0-30.
Sa 241	8X, 11.2S, 1.8W	Barkersville Parsonage	1933	1,160	Dug-Drl	24	6	0	Crystalline rock	13	--	D	Crystalline rock 20-24. Well drilled in bottom of 20-ft dug well.
Sa 242	8X, 10.8S, 5.3W	Michael Davidczuk	1941	1,000	Drl	86	6	--	Sand and gravel	8	10	D,S	Sand and gravel 0-83, cemented gravel 83-86.
Sa 243	8X, 7.5S, 5.9W	P. E. Lockhart	1940	840	Drl	116	8	69	Crystalline rock	25	8	D,S	Till 0-69, crystalline rock 69-116.
Sa 244	8X, 10.2S, 1.5W	Saratoga County Tuberculosis Hospital	1914	1,360	Drl	93	6	--	Sand	--	--	P	Till 0-?, sand ?-102. Well is filling with sand.
Sa 246	8X, 10.8S, 2.0W	Barkersville School Dist. No. 2	--	1,260	Drl	50	--	--	Sand and gravel	40	--	P	Sand, till boulders, gravel 0-50.
Sa 247	8X, 9.9S, 2.5W	Providence School Dist. No. 2	--	1,400	Drl	102	--	--	do.	20	--	P	Gravel, till, sand and gravel 0-102.
Sa 248	9X, 1.4N, 2.8E	Carl Conde	--	520	Dug	16	48	--	Gravel	15.5 12/ 5/46	--	D	
Sa 249	9X, 2.0N, 3.7E	Arthur Theyer	--	430	Drl	72	--	--	Sand and gravel	6	5	D	
Sa 250	8X, 15.5S, 2.8W	Edward Ruback	--	970	Orl	46	6	3	(See remarks)	12	10	D	Well reported to penetrate carbonate rock. May penetrate dolomite layers in sandstone unit.
Sa 251	8X, 16.2S, 2.7W	William Folster	1946	960	Drl	50	6	4	do.	25	2	D	Do.
Sa 252	8X, 7.0S, 7.2E	McKinley	--	620	Drl	45	6	5	Sandstone	--	--	C	
Sa 253	8X, 7.2S, 6.5E	do.	--	590	Drl	80	6	--	Sand and gravel	20	--	D,S	Sand and gravel 0-80.
Sa 254	8X, 2.5N, 8.5E	Joseph Reeves	--	600	Drl	225	6	--	Sand	140	--	D	Fine sand 0-225. Casing open at bottom.
Sa 255	8X, 1.9N, 7.7E	Charles Reed	--	630	Drl	108	6	30	Crystalline rock	30	--	D	Sand and gravel, 0-30, granite 30-108.
Sa 256	8X, 3.6N, 6.7E	Fedter	--	730	Drl	95	6	45	do.	20	--	D	Till 0-45, crystalline rock 45-95.
Sa 257	8X, 3.6N, 6.8E	Joseph McCarthy	--	630	Drl	72	6	0	do.	flows	3	D	Crystalline rock 0-72.
Sa 258	8X, 3.7N, 5.0E	Harry Wilcox	--	800	Drl	140	6	128	do.	--	3	D	Till 0-60, loose sand 60-114, cemented sand 114-128, crystalline rock 128-140.
Sa 259	8X, 4.8N, 3.6E	Conklingville School	--	800	Drl	174	6	--	Sand	60	15	P	Sand 0-70, till 70-174. Fine sand at 174.
Sa 260	8X, 3.1N, 2.8E	Greisenhomer	--	860	Drl	100	6	30	Crystalline rock	20	--	D	Sand 0-30, crystalline rock 30-100.
Sa 261	8X, 7.8N, 3.5E	Bowen	--	1,140	Drl	50	6	10	do.	20	--	D,S	Disintegrated black and red rock 0-50.
Sa 262	8X, 7.5N, 6.3E	John Briner	--	620	Drl	90	6	--	Sand and gravel	20	--	D	Sand, gravel, boulders 0-90.
Sa 263	8X 6.0S, 7.1E	Church Parsonage	--	620	Drl	42	6	25	Sandstone	--	6	D	Till 0-25, sandstone 25-42.

Table 1-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date com-ple-ted	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 264	8X, 8.2S, 5.7E	F. Niznik	--	700	Drl	80	6	30	Sandstone	--	--	D	Till, 0-30, sandstone 30-80.
Sa 265	8X, 12.4S, 7.8E	George DeWitt	--	390	Drl	132	6	65	Shale	--	--	D,S	Sand 0-65, shale 65-132.
Sa 266	8X, 3.7N, 6.0E	C. F. Genthner	1940	700	Drl	98	8	--	Sand and gravel	23	6	--	Sand and gravel, 0-98.
Sa 267	8X, 2.3S, 5.3W	Shufelts Garage	--	960	Dug	26	--	--	Till	21	--	D	Till 0-26.
Sa 268	8X, 2.0S, 5.2W	M. Brownell	1906	920	Drl	100	6	100	do.	80	--	D	Sand 0-7, till 7-100, carbonate rock at 100.
Sa 269	8X, 5.8S, 5.3W	Dr. Sano	--	800	Drl	57	6	--	Gravel in till(?)	--	30	D	
Sa 270	8X, 1.0N, 3.6W	Parker Brownell	1946	880	Drl	72	6	--	Sand	22	2	D,C	White sand 0-72.
Sa 271	9X, 4.8N, 0.3E	Donald Hall	--	940	Drl	70	6	60	Sandstone	--	--	D	
Sa 273	9X, 3.0N, 7.6E	B. March	1941	420	Drl	98	6	96	Shale	20	--	D	Sand 0-34, till 34-96, shale 96-98.
Sa 274	9X, 2.9N, 6.3E	A. G. Lowell	--	430	Dug	17	--	--	Sand	16	--	D	
Sa 275	9X, 3.0N, 6.4E	Gilbert Corcutt	--	430	Drl	25	6	--	Sand and gravel	17	--	D	
Sa 276	9X, 3.0N, 6.3E	William Mitchel	--	430	Drl	32	6	--	do.	14	5	D	
Sa 277	9X, 2.7S, 10.4E	H. C. Bormann	1925	330	Drl	62	6	--	do.	20	--	D	
Sa 278	9X, 2.0S, 10.6E	Cary Strang	--	340	Drv	18	1¼	--	do.	14	2	D	
Sa 279	8X, 8.4S, 8.7E	H. L. Hall	1941	700	Drl	92	6	3	Sandstone	30	15	C,S	
Sa 280	8X, 8.4S, 8.6E	do.	1941	720	Drl	72	6	20	do.	26	3	D	Till 0-20, sandstone 20-72.
Sa 282	8X, 8.2S, 7.8E	Charles Scott	1941	680	Drl	85	6	21	do.	30	15	D	Till 0-21, sandstone 21-85.
Sa 283	8X, 8.4S, 9.5E	A. Millar	1941	660	Drl	36	6	6	do.	10	6	D	Till 0-6, sandstone 6-36.
Sa 284	8X, 8.1S, 6.5E	Alexander Dalla Valle	1941	640	Drl	59	6	20	do.	--	2	D	
Sa 285	8X, 5.6S, 8.6E	Henry Hartman	1939	720	Drl	45	6	--	Till	--	5	D	Till 0-45. Well drilled in bottom of 17-ft dug well.
Sa 286	8X, 0.8S, 7.9E	Lester Eggleston	--	620	Drl	72	6	--	Sand	20	6	D	Gray sand 0-36, yellow sand 36-40, dark sand 40-71.
Sa 287	8X, 10.1S, 8.2E	U. S. Dept. of Agriculture	1940	560	Drl	133	6	31	Carbonate rock, sand-stone, and crystalline rock	72	10	C	Till 0-31, carbonate rock 31-75, sandstone 75-115, gneiss 115-133. Well yielded 2 gpm at 37 ft, 3 gpm at 91 ft, and 10 gpm at 127 ft.
Sa 288	8X, 9.9S, 8.2E	do.	1939	580	Drl	128	6	3	Carbonate rock	--	--	C	Till 0-3, carbonate rock 3-128.
Sa 289	8X, 10.6S, 8.3E	Jesse Bowman	1916	470	Drl	45	6	5	do.	20	--	D	
Sa 290	8X, 10.9S, 8.9E	P. W. and C. V. Dake	--	340	Drl	65	8	6	do.	8	25	C	
Sa 291	9X, 0.5N, 7.9E	Hide's-Franklin Mineral Springs	--	280	Drl	720	5	19	Shale and carbonate rock	flows	--	C	Water bottled and marketed for table and medicinal uses. Carbon dioxide from this well used to carbonate beverages. Analysis (N. Y. State Legislative Rept. no. 70, p. 105) shows total solids of 20,542 ppm.
Sa 292	8X, 11.3S, 10.8E	East Side Creamery	1939	320	Drl	450	8-6	2	Carbonate rock	6	25	C	Carbonate rock 2-450.
Sa 293	8X, 7.1S, 8.7E	Paul Chersnik	--	790	Drl	53	6	17	Sandstone	15	30	D,S	Till 0-17, sandstone 17-53.
Sa 294	8X, 10.8S, 7.5E	New Worden Hotel	--	600	Drl	93	3	--	Till	20	--	D	Till 0-98.
Sa 295	8X, 7.3S, 8.6E	W. G. Benton, Jr.	1947	790	Drl	92	6	4	Carbonate rock	50	25	--	Till 0-4, carbonate rock 4-92.
Sa 296	8X, 6.6S, 11.4E	David Hall	1946	680	Drl	53	6	8	Crystalline rock	9	6	D	Till 0-8, crystalline rock 8-53.

Table 1-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 299	8Y, 2.4N, 5.5E	Michael Urawicz	1947	350	Drl	123	6	--	Gravel	30	3	D	Sand 0-75, clay 75-100, gravel and boulders 100-123.
Sa 300	8X, 5.0N, 7.3E	Mrs. V. Hoffman	1947	620	Drl	89	8	--	Sand	27	--	D	Sand, boulders, and sand 0-89.
Sa 302	8X, 1.5N, 3.0E	K. Ulrich	1947	1,120	Drl	58	6	--	Sand and gravel	48	15	D	Sand, boulders, gravel 0-58.
Sa 303	8X, 0.8N, 5.3E	C. A. Duell	--	1,220	Drl	70	6	53	Crystalline rock	--	--	D	Till 0-53, crystalline rock 53-70.
Sa 304	8X, 1.2N, 4.0E	Camp Tawis-Kau-Ou	--	1,190	Drl	40	6	--	Till	--	--	P	Till 0-40.
Sa 305	8X, 0.4S, 4.4W	Raymond Mills	--	800	Drl	109	6	36	Crystalline rock	22	--	D	
Sa 306	8X, 4.0N, 1.5W	Marshall DeLong	--	1,170	Dug	16	36	--	Till	2	--	D	
Sa 307	8X, 2.5S, 9.0E	S. W. Flansburg	--	660	Drl	38	6	--	do.	22	5	D	Sand 0-30, till 30-38.
Sa 309	8X, 3.8S, 9.6E	Claude Woodcock	--	760	Dug	20	--	--	do.	--	--	D	Well goes dry during dry seasons.
Sa 310	8X, 2.7S, 10.6E	Town of Corinth School Dist. No. 3	--	710	Drl	90	--	0	Crystalline rock	--	--	P	Crystalline rock 0-90.
Sa 311	8X, 3.5S, 8.8E	M. C. Haines	--	750	Drl	55	--	--	Till	27	--	D	Till 0-55.
Sa 312	8X, 1.6S, 10.6E	Fred Morehouse	--	690	Drl	26	--	12	Crystalline rock	2	20	D	Sand 2-4, till 4-12, crystalline rock 12-26.
Sa 313	8X, 1.5S, 9.9E	Chauncey Lyng	--	640	Drl	30	--	14	do.	22	4	D	Sand 0-14, crystalline rock 14-30.
Sa 314	8X, 1.6S, 8.9E	S. J. Eggleston	--	660	Dug	24	36	--	Till	18	--	D	
Sa 315	8X, 1.3S, 10.1E	Fred Clothier	--	650	Drl	60	--	15	Crystalline rock	--	--	D	Sand 0-15, crystalline rock 15-60.
Sa 320	8X, 10.2S, 4.0E	Henry Hoffman	--	660	Dug	20	48	--	Till	18	--	D	
Sa 321	8X, 10.9S, 4.5E	Middle Grove Cematery	--	570	Drl	40	6	--	Sand	--	1	--	Sand 0-40.
Sa 322	9X, 4.3N, 4.3E	Cottrell Paper Co., Inc.	--	450	Drl	30	6	15	Carbonate rock	--	5	P	Supplies water for 20 employees.
Sa 323	9X, 4.5N, 4.1E	Florence Wright	--	480	Drl	59	6	4	do.	3	60	D	
Sa 324	9X, 4.2N, 3.4E	Arthur C. Driscoll	--	530	Drl	51	6	--	Sand and gravel	11	3	D	
Sa 325	8X, 4.0S, 1.3W	Dallas Bills	--	1,750	Dug	12	48	12	Till	6	--	D	
Sa 327	8X, 3.8S, 2.4W	William Partridge	--	1,520	Dug	9	--	--	do.	5	--	D	
Sa 328	8X, 3.5S, 3.2W	W. J. Edwards	--	1,230	Dug	11	--	--	do.	3	--	D	
Sa 329	8X, 2.7S, 3.5W	Thomas Olmsted	--	1,060	Dug	14	36	--	do.	5	--	D	
Sa 331	8X, 6.1S, 5.5W	Clifford Sparks	--	840	Dug	20	--	--	do.	10	1	D	
Sa 333	8X, 10.8S, 5.0W	Mrs. Cora Chase	--	1,000	Dug-Drv	40	48-1¼	--	Sand	--	--	D	Drive point and 1¼-inch pipe driven in bottom of 28-ft dug well. Supplies 7 families.
Sa 336	8X, 13.1S, 4.5W	Bert Comfort	--	1,060	Drl	162	6	--	Sandstone	75	--	D	Sand 0-?, till ?-160, sandstone 160-162.
Sa 337	8X, 12.9S, 3.0W	Glywa Bros.	--	1,120	Dug	14	48	--	Till	9	--	D	
Sa 338	8X, 13.8S, 3.0W	Walter Cwiakala	--	1,110	Drl	40	6	--	Sandstone	--	--	D	
Sa 340	8X, 14.7S, 3.7W	George Rossi	--	860	Drl	29	6	--	Carbonate rock	10	--	D	Aquifer contains alternating beds of sandstone.
Sa 341	8X, 14.1S, 3.1W	Stephen Gritkirewcz	--	1,030	Drl	28	6	5	do.	--	--	D	Do.
Sa 343	8X, 13.6S, 3.7W	Anatole Leopoldoff	--	1,080	Dug	55	48	55	Till	20	--	D,S	
Sa 344	8X, 11.8S, 2.0W	Thomas Soloway	--	1,150	Dug	20	48	--	do.	13	--	D	

Table I-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 345	8X, 15.0S, 1.8W	George Foote	--	790	Drl	39	6	--	Till	20	1	D	
Sa 346	8X, 15.9S, 0.7W	F. J. Seabolt	--	860	Drl	125	6	7	Carbonate rock	6	18?	D	Well reported to have been pumped at 18 gpm for 1 hr with drawdown of 12 ft.
Sa 347	8X, 13.0S, 1.1W	W. B. Armitage	--	910	Dug	28	48	--	Till	20	--	D	
Sa 348	8X, 8.6S, 5.2W	John Adamack	--	940	Dug	22	36	--	do.	--	--	D	
Sa 349	8X, 5.2N, 7.2E	Vincent Jowalszas	--	630	Drl	95	6	--	Gravel	--	--	D	Sand and boulders 0-90, gravel 90-95.
Sa 350	8X, 1.8N, 5.9W	Dyer Stockwell	--	1,360	Dug	22	48	22	Till	20	--	D	
Sa 351	8X, 1.5N, 4.9W	L. Craig	--	1,420	Dug	12	36	--	do.	4	--	D	
Sa 352	8X, 3.0N, 4.1W	A. B. Farrell	--	1,280	Dug	8	36	--	do.	3	--	U	
Sa 353	8X, 2.4S, 5.5W	Edinburg School	--	960	Drl	36	6	12	Sandstone	--	--	P	Till 0-12, sandstone 12-36.
Sa 354	8X, 2.7S, 5.5W	T. Edwards	--	960	Dug	12	36	--	Till	10	--	D	Well goes dry during dry seasons.
Sa 355	8X, 3.4S, 5.8W	H. E. Kadle	--	870	Dug	19	48	19	do.	12	--	D	
Sa 356	8X, 3.2S, 6.2W	B. Fraser	--	910	Dug	19	48	--	do.	10	--	D	
Sa 357	8X, 4.2S, 6.0W	Alois Malec	--	850	Dug	22	--	--	do.	12	--	D	Water level easily pumped below drop pipe during dry seasons.
Sa 358	8X, 1.5S, 5.7W	Pateau Airport	--	1,060	Dug	26	48	--	do.	16	--	D	
Sa 359	8X, 0.5S, 6.3W	Elwood Ferguson	--	1,210	Dug	13	36	--	do.	3	--	D	
Sa 360	8X, 3.8S, 4.6W	Sunset Grill	--	820	Dug	35	--	--	do.	--	--	D,C	
Sa 361	8X, 0.5S, 3.5W	Howard Weidlaw	--	810	Dug	20	36	--	do.	10	--	D,C	
Sa 362	9X, 3.5S, 1.4W	F. D. Schweizer	1937	700	Drl	250	6	60	Shale	27	5	D	
Sa 365	8X, 3.7S, 5.2E	John Lamore	--	880	Drl	130	6	100	Crystalline rock	--	--	D	
Sa 366	8X, 5.2S, 4.9E	Warren Outhwaite	--	870	Dug-Drl	29	48-1¼	--	Sand	--	--	D	Drive point and 1¼-inch pipe driven in bottom of 21-ft dug well.
Sa 367	9X, 3.6N, 2.5E	I. D. LeFevre	--	570	Drl	202	8	122	Shale	42	30	O	Well bailed at 40-50 gpm with drawdown of 160 ft.
Sa 368	9X, 2.6N, 3.6E	Florence Wright	--	440	Drl	165	6	--	Sand and gravel	19	--	D	Sand and gravel 0-20, clay 20-160, gravel 160-165.
Sa 369	8X, 4.3S, 6.7E	Lynch (Blossom Cottage)	--	730	Drl	68	6	26	Crystalline rock	--	--	D	
Sa 370	8X, 1.5N, 2.2E	Cecil White	--	940	Drl	125	6	--	Gravel	--	--	O	Gravel 120-125.
Sa 371	8X, 3.8N, 4.1E	Ralph Deitze	--	730	Dug	23	36	--	do.	9	--	D	
Sa 372	8X, 3.0N, 0.4W	Samuel Curran	--	800	Drl	48	6	0	Crystalline rock	20	4	D	
Sa 374	8X, 13.5S, 2.5W	R. J. Kimball	--	1,060	Dug	20	48	20	Till	10	--	D	
Sa 375	8X, 0.2S, 9.5E	Mrs. Michael Cohan	--	570	Drl	38	6	--	Crystalline rock	--	--	D	
Sa 379	8X, 7.5N, 4.7E	Mrs. Ashton	--	1,190	Drl	125	6	--	Gravel	--	--	D	Till, gravel 0-125.
Sa 380	8X, 8.0S, 1.8E	Kenneth McLea	--	1,570	Dug	12	--	--	Sand and gravel	6	--	D,C	
Sa 381	8X, 2.6N, 0.0W	Crandall	--	800	Drl	87	6	1	Crystalline rock	16	1	D	
Sa 382T	9X, 1.2N, 7.6E	Village of Ballston Spa	1942	390	Drl	73	--	72	Sand and gravel	20	--	T	Ballston Spa exploration well No. 1. Fine sand and clay 0-45, clay, some sand 45-70, gravel 70-72, shale 72-73.
Sa 383T	9X, 1.7N, 7.6E	do.	1942	400	Drl	53	--	50	do.	15	--	T	Ballston Spa exploration well No. 2. Sand and clay 0-30, clay, fine sand 30-48, gravel and sand 48-50, shale 50-53.

Table 1-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date com-ple-ted	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 384T	9X, 1.7N, 7.5E	Village of Ballston Spa	1942	410	Drl	63	--	63	Sand and gravel	15	--	T	Ballston Spa exploration well No. 4.
Sa 386T	9X, 2.9N, 6.9E	do.	1942	420	Drl	47	--	--	Sand	16	--	T	Ballston Spa exploration well No. 6. Fine-medium sand 0-20, sand and clay 20-44, sand, muck 44-47.
Sa 387	9X, 3.2S, 7.7E	J. Gaydoshek	1943	260	Drl	85	8?	25	Shale	--	--	D	
Sa 389	9X, 0.1S, 7.0E	Frank Plummer	--	340	Drl	250	6	19	do.	100	--	U	Till 0-19, shale 19-250. Water contains hydrogen sulfide.
Sa 390	9X, 0.3S, 5.9E	William Gage	--	370	Drl	258	6	20	do.	6	6	D	Sand 0-20, shale 20-258.
Sa 391	9X, 0.6S, 4.7E	Milton Schwenker	--	440	Dug	11	--	--	Till	6	--	D	Sand 0-11.
Sa 394	9X, 3.6S, 5.0E	R. Moon	--	420	Drl	120	6	40	Shale	--	--	D	
Sa 396	9X, 6.5S, 9.0E	George Charron	--	330	Drl	90	6	90	do.	--	--	U	Sand and gravel 0-90. Water is highly mineralized.
Sa 398	9X, 4.6S, 1.6E	Harold Foblen	--	500	Dug	24	--	--	Till	13	--	D,S	
Sa 399	9X, 5.2S, 1.5E	Harvey Litts	--	420	Drl	125	6	10	Shale	50	--	D	Water is highly mineralized.
Sa 400	9X, 2.8S, 1.0W	Emerson Markham	--	640	Drl	135	6	8	do.	--	1	D	
Sa 402	9X, 3.1S, 0.8W	George Bunyan	--	650	Drl	83	6	18	do.	12	12	S	Till 0-18, shale 18-83.
Sa 403	9X, 1.8S, 1.8W	Russel Arnold	--	820	Drl	100	6	38	do.	38	--	S	
Sa 405	9X, 1.8S, 2.3W	Mrs. Joseph Bagdan	--	840	Drl	120	--	18	Carbonate rock	--	--	D	Water contains hydrogen sulfide.
Sa 406	9X, 1.6S, 4.5W	Samuel Pikne	--	790	Drl	104	--	0	do.	--	--	D,S	
Sa 407	9X, 1.4S, 4.7W	George Summers	--	770	Drl	73	6	--	do.	20	--	D	
Sa 408	9X, 2.0S, 3.8W	Stephen Cetnar	--	760	Drl	105	6	10	do.	20	--	D,S	
Sa 410	9X, 0.2S, 1.5W	Alexander Shoutls	--	840	Dug	18	36	--	Till	14	--	D	
Sa 411	9X, 2.8S, 1.5W	West Charlton School Dist. No. 4	--	690	Drl	105	6	--	Shale	--	--	P	
Sa 412	9X, 2.8S, 2.0W	Hervert Speanburg	--	730	Dug	12	48	--	Till	9	--	D,S	
Sa 413	9X, 2.3S, 1.4W	J. N. Arnold	--	720	Drl	100	6	2	Shale	--	--	D,S	
Sa 414	9X, 0.1S, 6.3E	William Griffin	1937	380	Drl	180	8	60	Till	45	3	D	Sand and gravel 0-60, shale 60-180.
Sa 416	9X, 3.4S, 0.2E	Elmer Smith	--	580	Dug	12	--	--	do.	--	--	D	
Sa 417	9X, 1.8S, 1.2E	C. A. Holbrook	1946	590	Drl	93	8	22	Shale	3 7/ 3/47	--	U	Till 0-22, shale 22-173. Very low yield. Well is abandoned.
Sa 418	9X, 1.6S, 0.4E	J. C. Watkins	--	--	Dug	25	36	--	Till	6 7/ 2/47	--	D,C	
Sa 419	9X, 1.5S, 2.3E	Frank Cudo	--	540	Dug	22	--	--	do.	18	--	D	
Sa 420	9X, 2.9S, 4.1E	Frank W. Arnold	--	460	Drl	35	6	35	Gravel	--	--	S	Water from gravel on top of bedrock. Well supplies 60 head of cattle.
Sa 421	9X, 4.4S, 4.3E	R. Cunningham	--	440	Dug	18	36	--	Till	10 7/ 2/47	--	D	
Sa 422	9X, 2.5S, 10.5E	George Scelzi	--	330	Drv	32	1¼	--	Sand and gravel	--	--	D,C	
Sa 423	9X, 2.1S, 9.8E	Leon Van Aernem	--	330	Drl	63	6	13	Shale	30	--	D,S	
Sa 424	9X, 2.8S, 8.6E	J. Weed	--	320	Drl	82	6	16	do.	--	--	D	Water contains hydrogen sulfide.

Table I-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 425	9X, 4.0S, 8.8E	George Owen	1946	380	Drl	168	6	11	Shale	20	12	D,S	
Sa 426	9X, 3.9S, 9.2E	C. A. Johnson	--	320	Drl	90	6	--	do.	--	--	--	Water contains hydrogen sulfide.
Sa 427	9X, 4.8S, 9.7E	Howard Baker	--	260	Drl	190	6	50	do.	30	2	D,S	Blue clay and gravel 0-50, shale 50-190.
Sa 428	8X, 1.2N, 4.8E	C. G. Suits	1947	1,200	Drl	62	8	--	Gravel	4	15	D	Till 0-60, gravel 60-62.
Sa 429	8X, 5.8S, 5.5W	Albert Schobert	--	800	Drl	115	6	--	Sand	--	6	D,C	
Sa 431	9X, 0.5S, 10.2E	John Thompson	--	310	Drv	13	1¼	--	Sand and gravel	10	--	D,S	
Sa 432	9X, 2.3S, 6.2E	Charles Trebe	--	360	Drl	139	6	28	Shale	--	3	D,A	Blue clay 0-?, till ?-28, shale 28-139. Water contains hydrogen sulfide.
Sa 433	9X, 1.2S, 6.0E	Niels Christensen	--	420	Dug	26	36	--	Till	16	--	S	
Sa 434	9X, 3.1S, 6.3E	James Mallery	--	400	Drl	40	6	--	Shale	20	5	D,S	Water contains hydrogen sulfide.
Sa 435	9X, 2.3S, 4.8E	Gordon Miller	--	460	Drl	67	6	14	do.	14	4	S	
Sa 436	9X, 2.5S, 3.0E	Mrs. Edith Smith	--	540	Dug	40	36	--	Till	--	--	D	
Sa 437	9X, 3.8S, 3.3E	Rose Shadick	--	480	Dug	17	36	--	do.	9 7/ 9/47	--	D	
Sa 438	9X, 3.8S, 1.9E	J. H. Clute	--	--	Dug	12	144	--	do.	--	--	S	Well goes dry during dry seasons.
Sa 440	9X, 5.7S, 2.6E	H. Bogue	--	400	Drv	11	2	--	Sand	--	3	D	
Sa 441	9X, 5.9S, 3.3E	A. R. Brown	--	400	Drv	9	1¼	--	do.	--	--	D,S	
Sa 442	9X, 4.1S, 9.6E	George Roerig	1913	310	Drl	142	6	11	Shale	--	--	--	
Sa 443	9X, 3.5S, 1.4E	Jennie Finkle	1946	590	Drl	202	6	10	do.	42	--	D	
Sa 445	9X, 2.7S, 1.3E	D. Stockheim	--	630	Dug	25	36	25	Till	15	--	D	
Sa 446	9X, 1.0S, 1.1E	Edward Jacobs	--	620	Dug	30	--	--	do.	15	--	D	
Sa 447	9X, 1.1S, 7.3E	Harold Carpenter	--	350	Drv	20	1¼	--	Sand and gravel	18	--	S	Drive point hit very hard material at 20 ft.
Sa 448	9X, 0.9S, 7.4E	Tam-O-Shanter Inn	--	360	Drl	167	6	37	Shale	--	--	U	Yield inadequate. Water for Inn is obtained from 29-ft deep dug well in gravel.
Sa 449	9X, 1.0S, 3.4E	Roy A. Garrison	--	490	Dug	2	36	--	Till	15	--	D	Well goes dry during dry seasons.
Sa 450	9X, 0.7S, 9.2E	J. M. Brownell	--	330	Dug	28	36	--	do.	18	--	D	
Sa 451	9X, 3.7S, 11.2E	Norman Smith	1930	200	Drl	65	6	33	Shale	--	--	--	
Sa 453	9X, 0.6S, 10.6E	R. W. Vincent	1939	330	Drl	90	6	50	do.	20	5	D,A	Sand 0-50, black shale 50-90.
Sa 454	9X, 0.6S, 11.3E	Walter Bortell	--	310	Drl	87	10	--	Sand and gravel	20	--	D,S	Sand and gravel 0-87.
Sa 455	9X, 1.1S, 12.0E	C. E. Picotte	1947	300	Drl	332	6?	83	Shale	--	3	D	Sand 0-83, black shale 83-332.
Sa 456	9X, 1.0S, 11.5E	G. F. Willison	1947	240	Drl	358	6	95	do.	30	45	D	
Sa 457	9X, 1.0S, 9.1E	G. W. Denton	1900	320	Drl	40	6	30	do.	14	--	D,S	
Sa 458	9X, 1.9S, 9.0E	L. Madison	--	300	Dug	25	72	25	Till	20	--	D	
Sa 459	9X, 1.5S, 9.4E	Ernest Rosenbrock	--	300	Dug	9	24	--	do.	2.5 7/16/49	--	D	
Sa 460	9X, 1.1S, 8.4E	Frank Prock	--	300	Dug	50	36	--	do.	20	--	D,S	

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Table I-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 461	9X, 1.2S, 10.8E	M. S. Murphy	--	330	Brd	35	4	--	Sand	29	--	D,C	Sand 0-32, clay 32-35.
Sa 463	8Y, 15.7S, 2.9E	O. Soundquist	1945	410	Drl	90	6	--	Shale	--	--	D	Water contains hydrogen sulfide.
Sa 464	8Y, 15.7S, 1.4E	Louis Fraticelli	1940	280	Drl	100	6	3	do.	10	10	D	
Sa 466	8Y, 16.8S, 2.2E	William Burke	1947	400	Drl	95	8	17	do.	16	8	D	Sand 0-17, shale 17-95.
Sa 467	9Y, 0.4N, 3.5E	Griffin & Hale	1946	480	Drl	100	6	16	do.	24	10	D,S	
Sa 468	8Y, 11.5S, 0.2E	T. G. Schrade	1944	240	Drl	63	8	--	Sand and gravel	18	20	U	Sand and gravel 0-63. Drawdown 32 ft after pumping 20 gpm for 30 min.
Sa 469	9Y, 1.1S, 4.0E	Mary W. Nolan	1850	370	Dug	20	48	--	Till	10	--	D,S	
Sa 470	9Y, 0.9S, 3.2E	James Grooznack	1931	400	Dug	14	36	10	Shale	12	--	D	Sand and gravel 0-10, shale 10-14.
Sa 471	9Y, 0.6S, 1.8E	T. G. Coon	1800±	400	Dug	20	36	4	do.	12	--	D,C	Shale 4-20.
Sa 472	8Y, 10.7S, 8.5E	Joseph Kelly	1939	130	Drl	65	6	5	do.	15	--	D	
Sa 473	8Y, 12.2S, 8.4E	Riley DeVoe	1946	100	Drl	70	6	--	do.	15	--	D	Temp 51°F, 9/2/47.
Sa 474	9Y, 2.9S, 3.8E	George Canfield	1900±	320	Dug	14	96	11	do.	flows	--	D	Clay 0-11, shale 11-14. Temp 53°F, 8/28/47.
Sa 475	9Y, 3.2S, 4.0E	C. W. Neilson	1918	320	Drl	90	6	2	do.	23	--	D,S	Shale 2-90. Well drilled in bottom of 25-ft deep dug well.
Sa 476	9Y, 3.1S, 5.1E	Nicholas Petruszak	1900	140	Dug	18	36	2	do.	15	--	D	Shale 2-18.
Sa 477	9Y, 10.5S, 3.2E	W. E. Pearse	1930	230	Dug	12	36	--	Sand	10	--	--	
Sa 479	9Y, 10.6S, 3.8E	Frank Gero	1920	50	Drl	42	6	--	Shale	3	--	D,C	Water contains hydrogen sulfide.
Sa 491	8X, 12.8S, 10.7E	Saratoga Springs Authority, State of New York	1944	310	Drl	325	10-6	185	Carbonate rock	--	100	C	"Lincoln Spring No. 12." Sand 0-54, clay 54-91, till 91-185, shale 185-281, carbonate rock 281-325. Cased to 325 ft.
Sa 492	8X, 11.8S, 10.9E	do.	1905	310	Drl	497	3	62	do.	--	--	C	"Hathorn Spring No. 1." Well originally drilled to 1,015 ft. Water is pumped from a 1¼-inch pipe capped at the bottom and perforated between depths of 482 and 497. The 3-inch hole is sealed above and below the perforation.
Sa 493	8X, 14.0S, 9.5E	do.	--	310	Drl	540	10-8	23	do.	10	1	C	"Hathorn Spring No. 2." Blue clay 0-23, some gravel at 23, shale 23-75, shale and carbonate rock 75-455, carbonate rock 455-540.
Sa 495	8X, 13.8S, 9.6E	do.	--	310	Drl	420	6	9	do.	38	15	C	"Coesa Spring." Till 0-9, shale 9-169, carbonete rock 169-420.
Sa 496	8X, 14.2S, 9.0E	do.	1916	330	Drl	635	6	75	do.	0	--	U	Smith Experimental well. Sand, clay, till, 0-75, shale 75-275, carbonate rock 275-635.
Sa 499	8Y, 11.0S, 3.3E	M. L. Sotomeyor	--	280	Drl	178	8	27	Shale	145	7	D	Sand 0-15, till 15-27, shale 27-178.
Sa 503	9X, 2.6N, 3.4E	C. W. Lewis	--	440	Drv	16	1¼	--	Sand	12	3	D,S	
Sa 504	9X, 1.6N, 1.4E	Miles Weaver	--	550	Dug	17	48	--	Sand and gravel	16	--	D	
Sa 505	9X, 2.3N, 1.3E	Jacob Abramson	--	540	Drl	172	6	72	Shale	25	10	D,S	
Sa 506	9X, 2.6S, 12.1E	U. S. Army?	1946	330	Drl	430	--	210	do.	--	15	U	Yellow sand 0-60, fine gray sand 60-120, blue clay and fine gray sand 120-200, till 200-210, shale 210-430. Well is abandoned.
Sa 507	9X, 2.6S, 12.1E	do.	1947	330	Drl	82	12-8	--	Sand	--	--	--	Sand and clay 0-61, quicksand 61-82. Well cased to 62 ft and has 20-ft screen. A 30-gpm pump is installed.
Sa 509	9Y, 3.0S, 3.4E	William Joly	1946	320	Drl	95	8	23	Shale	30	1	D	Till 0-23, shale 23-95.
Sa 510	8Y, 13.5S, 1.0E	George Riley	--	260	Drv	24	1¼	--	Sand and gravel	16	--	D	
Sa 511	8Y, 12.5S, 0.6E	Joseph Smith	--	230	Drl	125	6	117	Shale	25	--	D	Gravel and sand 0-12, blue clay 12-113, quicksand 113-117, shale at 117

Table 1-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 513	8Y, 11.5S, 0.4E	Mrs. Mary DeLorenze	1943	240	Drl	110	6	110	Shale	--	--	U	Not used because of high iron concentration.
Sa 515	8Y, 11.1S, 2.4E	N. E. Hamm	1905	240	Drl	50	6	40	do.	25	3	D	
Sa 517	8Y, 10.5S, 2.5E	Earl Beagle	1935	280	Dug	11	36	--	Sand	3	--	D	
Sa 518	8Y, 9.1S, 2.3E	E. Traver	--	320	Drv	15	1¼	--	do.	5	--	D	
Sa 520	8Y, 10.4S, 0.5E	Marvin Anthony	1946	320	Drv	40	1¼	--	do.	--	--	D,S	
Sa 521	8Y, 5.1S, 1.0E	Frank Petteys	1900	320	Drl	23	6	3	Carbonate rock	--	--	D,S	
Sa 522	8Y, 9.0S, 1.2E	R. J. Benton	1940±	290	Drv	31	1¼	--	Sand	21	4	D	
Sa 523	8Y, 7.7S, 1.8E	Charles Bollmayer	--	320	Drv	12	1¼	--	do.	--	--	D	
Sa 525	9X, 6.3S, 11.5E	W. J. Gregoire	1947	210	Drl	145	6	70	Shale	45	6	D,S	
Sa 526	8Y, 3.6N, 8.0E	Arkell and Smith	1940	240	Drl	301	10-8	19	Carbonate rock	52	300	C	Drawdown 8 ft after pumping 300 gpm for 24 hrs.
Sa 527	do.	do.	1940	255	Drl	164	8-6	12	do.	93	50	C	Drawdown 12 ft after pumping 50 gpm for 24 hrs.
Sa 528T	9X, 2.7N, 2.3E	U. S. Atomic Energy Comm.	1949	500	Drl	675	8	17	Shale	--	20	T	(a). Till 0-17, black soft shale 17-22, black hard shale (containing traces of pyrite) 22-300, black hard shale (containing thin seams of calcite and pyrite) 300-500, shale and limestone in alternating layers (percentage of limestone increasing with depth) 500-600, gray and white crystalline limestone and dolomite 600-650, coarsely crystalline dolomite (some limestone) 650-700. Well yields flammable gas.
Sa 529	8X, 13.2S, 10.2E	Saratoga Springs Authority, State of New York	--	306	Drl	189	6	--	do.	46.3 6/25/59	--	T,O	Water-level fluctuations recorded by U. S. Geological Survey since May 1949.
Sa 533	9X, 14.4S, 10.1E	Latham Water Dist.	1946	200	Drl	103	12-10-8	97	Sand and gravel	10	--	T	Clay 0-34, sand, gravel, cobbles 34-46, clay 46-91, till 91-97, shale at 97. Screen set between 34 and 46.
Sa 534	9X, 14.6S, 10.3E	do.	1946	200	Drl	109	12-10-8	104	Till	15	--	T	Clay 0-11, sand, gravel and boulders 11-15, clay 15-81, till 81-109, shale at 109.
Sa 538	9X, 14.8S, 9.2E	do.	1946	200	Drl	83	12-10-8	76	Shale	11	--	T	Clay 0-51, till 51-57, clay 57-68, till 68-76, shale 76-83.
Sa 542	9X, 14.3S, 11.3E	do.	1946	200	Drl	150	12-8-6	144	do.	33	--	T	Clay 0-138, sand, gravel, boulders 138-141, till 141-144, shale 144-150.
Sa 543	9X, 13.6S, 10.8E	do.	1946	200	Drl	27	12	18	do.	--	--	T	Fill 0-5, sand 5-9, till 9-18, shale 18-27.
Sa 544	9X, 10.4E, 9.3S	Shenendehowa Central School	1951	320	Drl	48	6	--	Gravel	22	100	P	Fine-medium sand 0-25, fine gravel 25-30, coarse sand 30-40, fine gravel 40-48, clay 48-52. No. 60 screen from 40 to 48. Drawdown 6 ft after pumping 100 gpm for 12 hrs.
Sa 545	9X, 2.6N, 2.7E	U. S. Atomic Energy Comm.	--	460	Dug	7	30	--	Sand	1.9 4/29/48	--	D	(a). Temp 43°F, 4/29/48.
Sa 546	9X, 2.0N, 3.7E	Robert O. Harris	--	430	Dug	12	30	--	Till(?)	2.8 4/16/52	--	D	(a).
Sa 548	9X, 2.0N, 3.8E	Harry Stephens, Jr.	--	430	Dug	5	--	--	Till	0.8 4/16/52	--	D	Dry during summer of 1950.
Sa 550	9X, 1.9N, 5.1E	Adam Wojtowecz	--	450	Dug	20	48	--	do.	--	--	S	Supplies 23 livestock. A spring on property supplies water for house.
Sa 551	9X, 2.0N, 5.2E	Harry Nutting	1949	450	Drl	450	6	12	Shale	10	10	D	
Sa 552	9X, 1.9N, 5.2E	Stephen Breyo	1950	450	Dug	25	30	--	Till	8	--	C	Supplies restaurant.
Sa 553	9X, 2.0N, 5.6E	Blair Vaughn	--	450	Dug	15	48	15	do.	2	--	D	
Sa 554	9X, 2.1N, 5.7E	Charles Nutting	--	440	Dug	15	36	--	Till	3	--	D	

Table 1-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 555	9X, 2.0N, 5.7E	Michael Vargo	--	450	Dug	28	36	--	Till	10	--	D	Drilled well also on property.
Sa 556	9X, 2.2N, 5.6E	Jefferson Saunders	--	440	Dug	8	30	--	do.	6	--	D	
Sa 562	9X, 2.3N, 3.8E	Ernest Estes	--	430	Dug	15	--	--	Sand and gravel	3	--	--	
Sa 565	9X, 2.3N, 3.6E	Fred Baird	--	440	Dug	22	36	--	Sand	--	--	D	
Sa 566	9X, 2.4N, 3.6E	Town of Milton School Dist. No. 7	--	440	Drl	17	8	--	do.	12.1 9/24/52	--	P	(a). Temp 49.5°F, 9/24/52. Supplies small school and several nearby residences. High iron content.
Sa 568	do.	Leslie Barnes	--	440	Drv	14	1½	--	do.	10	--	D	
Sa 570	do.	Harold Burgess	--	440	Dug	14	36	--	do.	6	--	D	
Sa 572	9X, 2.5N, 3.6E	Charles Rougier	--	440	Drv	16	1¼	--	do.	--	--	D	Dry much of the time. Water from well Sa 566 is used to supplement supply.
Sa 574	do.	Arnol Knickerbocker	--	440	Dug	16	--	--	do.	11.9 5/24/58	--	D	Dry occasionally. Well Sa 1061 located on property.
Sa 575	9X, 2.6N, 3.6E	Ruth Barnes	--	440	Dug	18	36	--	do.	--	--	U	Water obtained from well Sa 566.
Sa 577	do.	Margaret Young	--	440	Drv	20	1¼	--	do.	16	--	D	Driven inside dug well.
Sa 578	9X, 2.6N, 3.7E	Karl Huber	--	440	Drv	22	1¼	--	do.	15	--	D	Do.
Sa 579	9X, 2.7N, 3.8E	E. Aubrey	--	440	Drv	20	1¼	--	Sand and gravel	12	--	D	Do.
Sa 580	do.	Jack Price	--	420	Dug	15	36	--	do.	6	--	D,S	
Sa 581	9X, 2.7N, 3.9E	Sylvia Sheren	--	420	Dug	20	30	--	Pleistocene gravel	12	--	D	
Sa 582	9X, 2.9N, 4.1E	Andrew Manz	1956	450	Drl	210	6	204	Shale	--	5	D	Well originally drilled to depth of 114 ft in 1951. Sand 0-20, till 20-30, sand, fine, silt, and clay 30-203, gravel 203-204, shale 204-210.
Sa 583	9X, 2.7N, 3.8E	Harold Kinnicutt	--	450	Dug	18	36	--	Sand	7	--	D	Well dug in cellar 6 ft below land surface.
Sa 584	9X, 3.0N, 4.5E	Ralph Derby	--	450	Drv	18	1¼	--	do.	--	--	C	
Sa 585	do.	George Hall	--	450	Drl	40	6	--	Gravel	15	10	D	
Sa 587	9X, 2.8N, 4.6E	Malvin Thayer	--	440	Drl	84	6	--	do.	40	10	D	Temp 50°F, 4/18/52.
Sa 588	9X, 2.7N, 4.8E	Warren Allen	--	410	Dug	12	48	--	do.	6	--	D	Goes dry during dry seasons.
Sa 589	9X, 2.8N, 5.0E	Oswell Ward	--	390	Dug	22	36	--	Sand	--	--	D	
Sa 591	9X, 2.8N, 5.1E	Donald Freer	--	390	Dug	17	36	--	do.	12	--	D	
Sa 592	9X, 2.8N, 5.2E	Lewis Nitchman	--	390	Drl	30	6	--	do.	10	5	D	Temp 47°F, 4/18/52.
Sa 594	9X, 2.8N, 5.5E	Jerry Mattison	--	380	Drv	27	1¼	--	Gravel	--	--	D	
Sa 596	do.	Edward Schermerhorn	--	380	Dug	25	30	--	Sand	21	--	D	
Sa 597	9X, 2.9N, 5.6E	Howard Baird	--	380	Drv	20	1½	--	do.	--	--	D	
Sa 598	9X, 2.7N, 5.6E	Robert Collamer	--	380	Dug	17	--	--	do.	7	--	D	Temp 46°F, 4/18/52.
Sa 600	9X, 2.5N, 5.6E	Paul Sukale	--	420	Drl	40	6	15	Shale	3	--	D	
Sa 601	9X, 2.6N, 5.6E	Herbert Collamer	--	410	Dug	20	48	--	Till	4	--	D,S	Bedrock or large boulder at bottom of well. Temp 46°F, 4/18/52. Water reportedly has high iron content.
Sa 602	9X, 2.8N, 5.8E	Peter Kirsebom	--	390	Dug	6	36	--	Sand	1	--	D	Temp 49°F, 4/22/52.
Sa 603	9X, 2.5N, 6.3E	Ralph Wallace	--	370	Drv	14	1¼	--	do.	5	--	D	(a). Temp 50°F, 4/22/52.

Table I-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 605	9X, 2.4N, 6.4E	Roland Morris	--	370	Dug	20	30	--	Gravel	7	--	D	
Sa 606	9X, 2.3N, 6.7E	James Ten Eyck	--	370	Dug	12	30	--	do.	7	--	D	
Sa 607	do.	John MacMillin	--	370	Dug	12	--	--	do.	6	--	D	
Sa 608	9X, 2.1N, 6.8E	H. Cooney	--	370	Dug	13	36	--	do.	5	--	D	
Sa 611	9X, 1.8N, 6.7E	Lawrence Morris	--	380	Dug	28	30	--	Till(?)	10	--	D	
Sa 615	9X, 1.8N, 6.9E	Chester Brooks	--	380	Dug	20	36	--	do.	4	--	D	Supplies four families. Temp 41°F, 4/22/52; 57°F, 9/24/52.
Sa 619	9X, 1.8N, 7.0E	Harold Baldwin	--	390	Dug	20	36	--	Sand	16	--	D	Temp 44°F, 4/22/52.
Sa 620	do.	Miles Wagner	--	390	Drv	13	1¼	--	do.	7	--	D	
Sa 621	9X, 2.0N, 6.9E	H. Rowland	--	380	Dug	18	--	--	Till(?)	--	--	D	
Sa 622	do.	Leon Howe	--	380	Dug	12	36	--	Gravel	2	--	D	Temp 43°F, 4/23/52.
Sa 626	9X, 1.8N, 7.0E	Clarence Jones	--	380	Drv	10	1¼	--	Sand	4	--	D	
Sa 629	9X, 1.8N, 6.8E	Homer Knowlton	--	370	Dug	18	--	--	Till(?)	--	--	D	
Sa 631	9X, 1.6N, 6.8E	Della Morris	--	360	Dug	12	36	--	Till	6	--	D	Temp 44°F, 4/24/52.
Sa 633	9X, 1.5N, 6.7E	Alfred Morris	--	360	Dug	28	--	--	Till(?)	22.7 4/24/52	--	D	
Sa 634	do.	Dennison Burdick	--	360	Dug	12	48	--	do.	4	--	D	
Sa 638	9X, 1.4N, 6.7E	Harmon Abell	--	360	Dug	10	36	--	do.	4	--	D	Goes dry during dry seasons.
Sa 642	9X, 1.3N, 6.7E	John Scanlon	--	360	Dug	18	30	--	do.	8	--	D	
Sa 643	9X, 1.2N, 6.7E	Mrs. Cora Hall	--	360	Dug	27	36	--	do.	4	--	D	
Sa 647	9X, 1.2N, 6.8E	Mrs. Ruth Peck	--	370	Dug	20	36	--	do.	15	--	D	Used to supplement supply from nearby dug well which is equipped with electric pump. Temp 43°F, 4/25/52.
Sa 648	do.	Daniel Clark	--	370	Dug	12	36	--	do.	8	--	D	Dry in 1948.
Sa 653	9X, 1.1N, 6.8E	Marshall Plummer	--	300	Dug	10	30	--	do.	3	--	D	
Sa 656	9X, 2.2N, 3.8E	Arthur Peck	--	430	Dug	8	30	--	Sand	4	--	D	
Sa 662	9X, 1.2N, 6.2E	Saratoga County Home	--	390	Dug	10	18	--	do.	--	--	D,S	Temp 46°F, 4/25/52.
Sa 663	9X, 1.5N, 6.5E	do.	--	390	Dug	11	144	--	do.	--	--	D,S	Temp 43°F, 4/25/52.
Sa 671	9X, 1.8N, 6.4E	A. J. Armstrong	--	410	Dug	25	36	--	Gravel	12	--	D	Goes dry during dry seasons.
Sa 673	9X, 1.8N, 6.6E	Mrs. Anna Kawecki	--	400	Dug	12	36	--	Sand	--	--	D	
Sa 674	do.	William Waldeck	--	360	Dug	22	36	--	do.	8	--	D	
Sa 675	9X, 1.2N, 6.5E	William Thompson	--	380	Dug	15	36	--	do.	--	--	D	Goes dry during dry seasons. Water reportedly contains hydrogen sulfide.
Sa 677	9X, 1.5N, 6.6E	Irving Keator	--	360	Dug	16	--	--	do.	6	5	D	
Sa 678	9X, 1.2N, 6.6E	Neil Lewis	--	360	Dug	16	36	--	Gravel	3	--	D	Water contains noticeable concentrations of iron and hydrogen sulfide. Temp 45°F, 5/12/52.
Sa 680	9X, 1.0N, 6.5E	Edward Johnson	--	380	Dug	8	36	--	Sand	2	--	D	Temp 46°F, 5/12/52.
Sa 683	9X, 0.6N, 6.6E	M. S. Porter	--	380	Dug	20	30	--	Gravel	10	--	D	

Table 1-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 684	9X, 0.6N, 6.6E	Leslie Paddock	--	380	Dug	25	36	--	Gravel	10	--	D	
Sa 686	9X, 0.7N, 6.6E	Ernest Mory	--	380	Dug	16	--	--	Sand	5	--	D	Well bottoms in clay. Temp 47°F, 5/12/52.
Sa 691	9X, 0.6N, 6.9E	Mrs. Sarah Murray	--	350	Dug	28	36	--	do.	10	--	D	
Sa 696	9X, 1.7N, 7.2E	Mrs. Elizabeth Booth	--	400	Drv	15	1¼	--	do.	--	--	D	
Sa 698	9X, 1.6N, 7.2E	Robert Baldwin	--	400	Drv	15	1¼	--	do.	10	--	D	
Sa 701	do.	Robert F. Lienau	--	400	Dug	9	--	--	do.	4.4 5/13/52	--	D	Temp 44°F, 5/13/52.
Sa 705	9X, 1.5N, 7.2E	Roy Boyce	1920	400	Drv	25	1¼	--	do.	14	--	D	
Sa 706	9X, 1.4N, 7.3E	George Plasay	1947	400	Dug	22	33	22	Gravel	15.4 5/14/52	--	D	Well bottoms on shale.
Sa 707	9X, 1.4N, 7.2E	Robert Boyce	--	400	Dug	18	30	--	do.	--	--	D	
Sa 711	do.	Lloyd McMann	--	400	Drv	22	1¼	--	Sand	--	--	D	
Sa 714	9X, 1.3N, 7.2E	Henry Baker	--	400	Dug	25	48	--	do.	15	--	D	
Sa 716	9X, 1.2N, 7.2E	Ralph Parker	--	400	Dug	21	24	--	do.	17.5 5/14/52	--	D	
Sa 718	9X, 1.4N, 7.4E	Donald Gilroy	--	400	Dug	14	30	--	do.	9	--	D	
Sa 720	do.	John W. Barnes	--	400	Drv	13	1¼	--	do.	2.2 5/15/52	--	U	Temp 46°F, 5/15/52.
Sa 721	9X, 1.4N, 7.3E	William J. Boyce	--	400	Dug	15	30	--	do.	--	--	D	
Sa 723	9X, 1.2N, 7.2E	Orland Woodruff	--	400	Drv	22	1¼	--	do.	--	--	D	
Sa 725	9X, 1.1N, 7.3E	Raymond Roner	--	400	Drv	31	1¼	--	do.	--	--	D	
Sa 728	9X, 1.1N, 7.4E	John Collins	--	400	Dug	35	48	--	do.	5	--	D	
Sa 730	9X, 1.1N, 7.0E	Edward Flinton	--	370	Dug	9	30	--	Till(?)	5.1 5/15/52	--	D	Temp 45°F, 5/15/52.
Sa 733	9X, 1.2N, 7.3E	Charles Pettit	--	400	Dug	34	36	--	Sand	--	--	D	Temp 46°F, 5/16/52.
Sa 735	9X, 1.1N, 7.9E	Carl Knuth	--	290	Dug	15	24	--	Till(?)	9	--	D	
Sa 747	9X, 1.1N, 7.4E	Herman LaBounty	--	400	Drv	28	1¼	--	Sand	18	--	D	Temp 47°F, 5/16/52.
Sa 753	8X, 16.1S, 8.9E	John Pompa	--	250	Dug	8	36	--	Till	4	--	D	
Sa 754	8X, 15.9S, 9.3E	Frank Ramsey	--	250	Drv	6	1¼	--	Sand	2	--	D	Temp 48°F, 5/16/52.
Sa 756	8X, 15.8S, 9.9E	Joseph Shaffer	--	250	Dug	30	36	--	Till	12	--	--	
Sa 759	8X, 15.7S, 10.3E	John Sokach	--	240	Drl	292	6	--	Shale	50	4	D	Dynamite was exploded in bottom of well after drilling.
Sa 761	8X, 15.5S, 11.0E	Myer Lavine	--	260	Dug	18	30	18	Till	4	--	--	Nearby drilled well yields water containing hydrogen sulfide.
Sa 765	8X, 14.5S, 11.8E	Joseph Hammer	--	220	Drl	225	6	150	Shale	30	--	U	Well water is black in color and contains hydrogen sulfide.
Sa 767	9X, 0.1N, 7.4E	Village of Ballston Spa	1874	270	Drl	647	6	--	do.	Flows	--	U	
Sa 771	9X, 0.2N, 7.6E	Unknown	1869	290	Drl	709	5	--	do.	13	--	C	Known locally as "San Souci Spring." Water from this well is bottled and sold. Analysis (N. Y. State Legislative Rept. no. 70, p. 195) shows total dissolved solids of 16,815 ppm.

Table I-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 775	8X, 14.9S, 12.2E	Lester Davis	--	220	Dug	20	48	--	Till	1	--	D,S	Drilled well on property draws water containing hydrogen sulfide from shale.
Sa 777	8X, 14.8S, 12.2E	do.	--	220	Drl	65	6	--	Gravel	15	5	D	
Sa 781	9X, 1.6N, 8.0E	Kenneth Thornhill	--	320	Dug	11	30	--	Sand	5	--	D	
Sa 782	do.	Charles Uline	--	380	Dug	22	36	--	do.	--	--	D	
Sa 783	9X, 1.5N, 7.7E	Charles Hallak	--	400	Drl	60	6	--	do.	15.6 5/29/52	7	D	
Sa 784	8Y, 11.2S, 3.2E	C. H. Clausen	1949	280	Drl	100	6	31	Shale	5	--	D	Yields less than 1 gpm.
Sa 785	8Y, 11.1S, 3.2E	Frank Max	--	280	Dug	10	30	--	Sand	5	--	D	
Sa 786	8Y, 13.1S, 1.1E	Elmer Robinson	--	264	Drv	16	1¼	--	do.	10	--	D	
Sa 787	8Y, 12.8S, 1.9E	Harold Loggin	--	260	Drv	20	2	--	do.	12	--	D	
Sa 788	8Y, 12.4S, 2.0E	John Giler	--	360	Drl	160	6	--	Shale	20	10	D	
Sa 789	8Y, 10.0S, 8.1E	Edward Graenwalt	--	220	Brd	22	6	--	Sand	flows	--	D	Temp 50°F, 6/4/52.
Sa 790	8Y, 9.9S, 7.2E	John Pritchard	1932	220	Drl	110	6	--	Shale	45	5	D	Water contains hydrogen sulfide.
Sa 791	8Y, 10.0S, 6.5E	Walter Nadeau	--	200	Dug	11	30	--	Sand	6.2 6/ 4/52	--	D	
Sa 792	8Y, 10.0S, 6.2E	Max Kretchmer	--	210	Drl	50	6	--	Shale	3.1 6/ 4/52	--	D	Water contains hydrogen sulfide.
Sa 793	8Y, 10.3S, 5.3E	Fred Shelton	--	220	Drl	81	6	--	do.	15.2 6/ 4/52	7	D	Drawdown 14 ft after pumping 7 gpm for 12 hrs. Water contains hydrogen sulfide.
Sa 795	8Y, 11.1S, 4.5E	Mrs. Ira Wander	--	210	Drv	20	1½	--	Sand	10	--	D	
Sa 796	8Y, 12.2S, 3.1E	Leon Robinson	1948	220	Drl	47	6	--	Shale	15	--	D	Water contains hydrogen sulfide.
Sa 797	8Y, 11.8S, 2.6E	Stephan Bederka	--	240	Drl	65	6	--	do.	15	--	D	
Sa 798	8Y, 11.2S, 3.9E	A. H. Pass	--	300	Drv	20	1¼	--	Sand	4	--	D	
Sa 800	8Y, 14.2S, 1.5E	R. C. Saunders	--	210	Drv	·19	1¼	--	Gravel	13	4	D	
Sa 802	8Y, 14.5S, 1.8E	William Lambeth	1943	220	Drl	66	6	6	Shale	6	8	D	Water contains hydrogen sulfide.
Sa 803	8Y, 15.1S, 1.7E	Frances Callahan	1941	230	Drl	85	6	38	do.	20	1	D	
Sa 804	8Y, 16.1S, 1.3E	S. V. Stevens	--	230	Drl	50	6	4	do.	5	2	D	
Sa 805	8Y, 16.9S, 0.9E	Robert Hillman	--	210	Drl	40	6	--	do.	15	--	D	Water contains hydrogen sulfide.
Sa 806	do.	do.	--	220	Drl	26	6	--	do.	16.6 9/ 3/52	--	D	Temp 50°F, 9/3/52. Water does not contain hydrogen sulfide.
Sa 807	8Y, 17.3S, 0.7E	M. DaSimona	1952	210	Drl	70	6	--	do.	flows	30	D,C	
Sa 808	do.	John F. Dalev	--	210	Drl	76	4	40	do.	flows	--	D	Supplies 17 cottages. Temp 50°F, 9/3/52.
Sa 809	9Y, 0.8S, 0.6E	Edward Gemmitl	--	220	Drl	65	6	65	do.	18	5	D,C	Water contains hydrogen sulfide.
Sa 811	9Y, 1.0S, 0.2E	Harold Brown	--	220	Drv	70	2	--	Sand	+3	5	D	Temp 50°F, 9/6/52.
Sa 813	9X, 0.9S, 12.6E	Karl Wilka	--	210	Drl	75	6	--	do.	flows	30	D	Temp 52°F, 9/6/52.

Table I-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 814	9X, 0.9S, 12.5E	Douglas Andrew	--	210	Drv	29	1¼	--	Sand	flows	5	D	Temp 51°F, 9/6/52. Owner reports water contains hydrogen sulfide following storms.
Sa 815	9X, 0.5S, 12.1E	Charles Mabey	--	210	Dug	9	36	--	do.	6	5	O	
Sa 817	9X, 0.3S, 12.1E	Joseph Frankwitt	--	220	Drl	435	6	2	Shale	17	5	O	Water contains hydrogen sulfide.
Sa 818	8X, 16.3S, 12.0E	I. Inglis	--	210	Drl	30	6	2	do.	7	5	D	Do.
Sa 819	8X, 16.5S, 11.9E	J. C. Dancer	1937	260	Drl	86	6	6	do.	50	2	D	No hydrogen sulfide in water.
Sa 821	8X, 16.9S, 12.1E	Mrs. Louise Cafarella	1947	210	Drl	114	6	--	do.	18	5	D	Water contains hydrogen sulfide.
Sa 822	8Y, 13.6S, 1.1E	H. E. Ryall	--	280	Drv	20	1¼	--	Sand	15	5	D	
Sa 825	8X, 15.8S, 12.4E	G. W. Mather	--	220	Drl	70	6	58	Shale	25	25	--	
Sa 827	9Y, 0.9N, 3.4E	U. S. Air Force, Air Defense Command	1950	600	Drl	526	10	10	do.	--	12	P	(b). Drilled to depth of 312 ft in 1950. Deepened to 526 ft in 1957. Yielded 12 gpm when 312 ft deep.
Sa 828	9Y, 0.8N, 3.4E	do.	1951	590	Drl	322	10	12	do.	21	--	U	(b). Yield 2 gpm at depth of 40 ft, 5 gpm at 70 ft, and 25 gpm at 322 ft. Use discontinued in 1957 because of low yield following deepening of well Sa 827.
Sa 829	9Y, 0.9N, 3.5E	do.	1950	580	Drl	468	10	20	do.	>130 9/18/58	10	P,S	(b). Precipitation of minerals (calcium carbonate?) on pump screen has necessitated removal of pump three times since submersible pump was placed in service in 1957. Till 0-22, shale 22-110, shale with interbedded carbonate rock 110-468.
Sa 831	8X, 13.8S, 9.9E	Saratoga Springs Authority, State of New York	--	230	Drl	300	6	15	Shale and carbonate rock	flows	25	P	Drinking fountain. Locally known as "Hayes Well." Flow in fountain cut to 1½ gpm to prevent it from diminishing flow of well Sa 837. Several other mineral wells in area. Flow of each well is affected by the flow of nearby wells.
Sa 833	8X, 11.3S, 11.3E	do.	--	280	Drl	171	10-6	42	do.	flows	--	U	Not used since closing of baths in 1917.
Sa 836	8X, 13.5S, 10.0E	do.	--	300	Drl	300	8-6	20	do.	flows	150	--	
Sa 837	8X, 13.7S, 9.9E	do.	1930	235	Drl	326	6	10	do.	flows	25	--	Locally known as "Island Well." Scenic spouting fountain will flow 25 gpm when flow from well Sa 831 is cut off.
Sa 838	9X, 2.1N, 2.6E	U. S. Atomic Energy Comm.	--	510	Dug	21	36	--	Till	6.6 10/18/54	--	U	Water-level fluctuations recorded by U. S. Geological Survey 1954-55. Temp 51°F, 10/18/54.
Sa 839	9X, 2.4N, 1.9E	do.	--	570	Dug	17	36	--	do.	10.2 10/18/54	--	U	Water-level fluctuations recorded by U. S. Geological Survey 1954-55. Temp 53.5°F, 10/18/54.
Sa 840	9X, 3.5N, 1.3E	do.	--	700	Dug	28	36	--	do.	11.7 10/22/54	--	U	Water-level fluctuations recorded by U. S. Geological Survey 1954-55. Temp 49.5°F, 10/18/54.
Sa 841	9X, 3.5N, 2.2E	do.	--	590	Dug	27	36	--	do.	17.3 10/22/54	--	U	Water-level fluctuations recorded by U. S. Geological Survey 1954-55. Temp 49°F, 10/18/54.
Sa 842	9X, 2.4N, 1.5E	do.	--	545	Dug	19	36	--	do.	16.3 10/18/54	--	U	Temp 50.5°F, 10/18/54.
Sa 843	9X, 3.5N, 3.3E	do.	--	410	Dug	25	5 ft x 8 ft	--	Sand and gravel	7.2 10/17/55	750	I	(a). Located 40 ft west of Kayaderosseras Creek. Well constructed with two horizontal collectors of 36-inch diameter, one 100-ft long, the other 20-ft long. Well produces 750 gpm with stabilized drawdown of 7 ft. One of 4 wells supplying the Atomic Energy Commission's reactor installation at West Milton. Water-level fluctuations recorded by U. S. Geological Survey 1955-59.
Sa 844T	9X, 3.2N, 3.1E	do.	1955	490	Drl	130	6	--	Sand	--	--	U,T	Well would not yield usable quantity of water. Sand and clay, interbedded 0-130.

Table I-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date com-ple-ted	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 845T	9X, 3.2N, 3.1E	U. S. Atomic Energy Comm.	1955	490	Drl	145	6	--	Sand and gravel	84	--	U,T	Water-bearing zone between 119 and 130 ft. Sand and clay, interbedded 0-145. Sand and gravel lense 123-130.
Sa 846T	do.	do.	1955	490	Drl	137	6	--	Sand	--	--	U,T	Well would not yield usable quantity of water. Sand and clay interbedded, some gravel 0-137.
Sa 847T	9X, 3.3N, 3.2E	do.	1956	405	Drl	107	6	--	Sand and gravel	+11.3 1956	--	U,T	Hydrogen sulfide reported. Sand and gravel, some silt interbedded 0-107.
Sa 848T	do.	do.	1956	402.5	Drl	99	12	--	Sand	+11.3 6/ 1/56	750	T	(a). Has yielded 750 gpm for 7 days with 23-ft drawdown. Finished with 12-inch screen from 79 to 99 ft. Temp 48°F, 4/23/56. One of four wells supplying the Atomic Energy Commission's reactor installation at West Milton. Sand and gravel, some silt 0-99. Water-level fluctuations recorded by U. S. Geological Survey 1956.
Sa 849T	9X, 3.4N, 3.3E	do.	1956	406.2	Drl	26	2	--	Sand and gravel	8.6 8/30/56	--	T	(a). Temp 47°F, 1/28/57. Sand, gravel, and cobbles 0-26.
Sa 850T	do.	do.	1956	405.2	Drl	85	2	--	Sand	+6.6 8/22/56	--	T	Sand and gravel with thin clay layers 0-85. Finished with 2-inch screen from 82 to 85 ft. Constructed and used for observation of water levels in artesian aquifer during pumping tests in April and December 1956.
Sa 851T	9X, 3.3N, 3.3E	do.	1956	402.9	Drl	85	2	--	do.	+8.7 8/22/56	--	T	Do.
Sa 852T	do.	do.	1956	402.5	Drl	85	2	--	do.	+9.2 8/22/56	--	T	Do.
Sa 853	9X, 2.6N, 3.6E	Stephen Podwirny	--	440	Drl	120	6	--	Gravel and silt	8.7 4/18/56	30	U	Water-producing zones were too thin for development of successful well. Silt heaved up into casing.
Sa 854	9Y, 1.3S, 5.5E	Nelson and Sarah Armlin	1951	280	Drl	200	6	25	Shale	3	1	D	
Sa 857	9X, 4.6N, 2.5E	Paul Gawrys	--	650	Dug	5	48	--	Till(?)	3	--	D,S	Sand aquifer overlies clay. Bedrock reported at depth of 8 ft.
Sa 858	9X, 4.3N, 2.8E	Ole Mortensen	--	580	Drl	37	6	--	Gravel	4	8	D	Well pumped at rate of 8 gpm for 24 hrs with 18 ft of drawdown.
Sa 859	9X, 4.2N, 3.5E	Michael Wasiluk	--	520	Dug	14	36	--	Till(?)	--	--	D,S	
Sa 860	9X, 4.1N, 3.4E	Harry Kit	--	520	Dug	20	36	--	do.	--	--	D	Temp 51°F, 8/29/56.
Sa 861	9X, 4.2N, 4.2E	Harry F. Jones	--	450	Drl	42	6	12	Carbonate rock	20	3	D,S	Temp 49°F, 8/29/56.
Sa 862	9X, 4.0N, 4.2E	J. L. Cottrell	--	440	Drl	71	6	--	Gravel	4	18	D	Well pumped at rate of 18 gpm for 20 min with 30 ft of drawdown.
Sa 863	do.	Delbert Stevens	1925	430	Drl	31	6	--	do.	19	5	D	
Sa 864	9X, 3.9N, 4.2E	F. L. Harrington	1951	430	Drl	81	6	--	do.	4	15	D	
Sa 865	9X, 3.8N, 4.2E	Robert Fuller	--	430	Dug	28	34	--	do.	20	--	D	
Sa 868	9X, 3.7N, 4.2E	J. F. Furness	1949	420	Drl	73	6	68	Shale	4	15	D	Sand and gravel 0-10, till 10-68, shale 68-73.
Sa 869	9X, 3.5N, 4.1E	Thomas Finley	--	470	Dug	20	60	--	Sand	--	--	D	
Sa 870	9X, 3.3N, 4.1E	Sam Bronzene	1952	460	Drl	105	6	--	Gravel	20	--	D	Clay and saturated silt overlie gravel aquifer.
Sa 871	do.	George M. Williams	--	460	Dug	55	36	--	do.	22	--	D	Temp 50°F, 8/30/56.
Sa 874	9X, 3.1N, 4.1E	Raymond Thomas	1953	450	Drl	64	6	--	do.	14	6	D	
Sa 876	9X, 4.4N, 4.4E	Bernard Green	--	480	Drl	32	6	--	do.	10	5	D	
Sa 877	9X, 4.8N, 3.2E	Boy Scouts of America, Schenectady Council	--	510	Dug	18	24	--	Sand	Dry 8/30/56	--	P	

Table 1-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date com-ple-ted	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 1025T	9X, 3.4N, 3.2E	U. S. Atomic Energy Comm.	--	416.4	Drl	78	6	--	Sand and gravel	3.8 12/26/58	--	T	Yields ¼ gpm with 1 ft of drawdown. Test well drilled to 85 ft to determine extent of artesian aquifer and for observation of water-level fluctuations during pumping test of December 1956-January 1957. Finished with 5-ft length of 6-inch screen. Sand and gravel 0-30, fine sand and silt 30-40, sand and gravel 40-75, fine gravel and clay 75-85.
Sa 1026T	9X, 3.3N, 3.2E	do.	--	410.7	Drl	85	6	--	Sand	+1.2 12/26/56	--	T	Test well drilled to 86 ft to determine extent of artesian aquifer and for observation of water-level fluctuations during pumping test of December 1956-January 1957. Finished with 5-ft length of 6-inch screen. Water-level fluctuations recorded by U. S. Geological Survey 1957-59. Till 0-15, sand and clay 15-55, sand 55-85.
Sa 1027T	9X, 3.3N, 3.3E	do.	--	399.6	Drl	78	6	--	do.	+12.2 12/26/56	--	T	Test well drilled to 85 ft to determine extent of artesian aquifer and for observation of water-level fluctuations during pumping test of December 1956-January 1957. Finished with 5-ft length of 6-inch screen. Sand and gravel 0-15, fine and coarse sand 15-75, till 75-85.
Sa 1028T	9X, 3.3N, 3.2E	do.	--	486.3	Drl	230	6	218	do.	77.4 12/26/56	--	T	Test well drilled to determine extent of artesian aquifer, depth to bedrock, and for observation of water-level fluctuations during pumping test of December 1956-January 1957. Cased to shale at 218 ft. Dynamited opposite artesian aquifer at 135 ft. Water-level fluctuations recorded by U. S. Geological Survey 1957-59. Till 0-65, clay and sand interbedded 65-160, till 160-218, shale 218-230.
1029T	9X, 2.3N, 3.2E	do.	--	402.8	Drl	30	6	--	Sand and gravel	1.6 12/26/56	--	T	Test well drilled to observe water-level fluctuations in water-table aquifer during pumping test of December 1956-January 1957. Finished with 5-ft length of 6-inch screen.
Sa 1030	do.	do.	--	400	Drl	74	16	--	Sand	+12	750	I	(a). Has yielded 750 gpm for 72 hrs but is not capable of yielding 900 gpm for any appreciable length of time. Finished from 44 to 74 ft in artesian aquifer with a 14-inch diameter number 18-slot screen. One of four wells supplying Atomic Energy Commission's reactor installation at West Milton.
Sa 1031	9X, 3.3N, 3.3E	do.	--	405	Drl	105	16	--	do.	+7	750	I	(a). Has yielded 750 gpm for 72 hrs and 900 gpm for short length of time. Finished in artesian aquifer with 14-inch diameter screen from 75 to 105 ft. Number 25-slot screen from 75 to 85 ft and 35-slot from 85 to 105 ft. One of four wells supplying Atomic Energy Commission's reactor.
Sa 1032	9Y, 1.0S, 5.7E	U. S. National Park Service	1929	300	Drl	294	6	--	Shale	50	2	P	(b). Temp 52°F, 7/30/58. Water chlorinated to counteract hydrogen sulfide. Pump cylinder set at depth of 288 ft.
Sa 1033	9Y, 1.1S, 6.6E	do.	late 1700's	310	Dug	35	30	--	Till(?)	7.1 4/18/58	--	U	Water level declined below suction lift of hand pump in winter 1948-49.
Sa 1034	9Y, 1.2S, 5.5E	do.	1927	310	Drl	67	6	50	Shale	12.2 4/18/58	--	O	Well is in abandoned picnic area.
Sa 1035	9Y, 2.0S, 6.0E	Fred Kussius	1956	100	Drl	80	6	10	do.	--	--	D	Odor of hydrogen sulfide appears with continued use. Water leaves iron stains on porcelain fixtures.
Sa 1036	9Y, 2.1S, 5.9E	Dan Tillapaugh	1956	100	Drl	35	6	0	do.	--	7	D	
Sa 1037	9Y, 1.9S, 6.0E	Vina Sharp	1952	120	Drl	156	6	15	do.	12	6	O	Water does not contain hydrogen sulfide.
Sa 1038	9Y, 1.3S, 5.4E	William Price	1952	290	Drl	35	6	10	do.	1.5 5/ 2/58	6	O,S	Drilled inside dug well 10 ft deep. Loses prime with continued pumping of ½ HP jet pump. Jet pipes are at a depth of 33 ft.
Sa 1039	9Y, 1.2S, 6.6E	Clifford Holmes	1956	100	Drl	30	--	--	do.	--	--	D,S	
Sa 1040	9Y, 0.7N, 7.8E	William and Alice Fort	1954	90	Drv	26	4	--	Sand	--	--	D	
Sa 1041	9Y, 0.8N, 7.8E	Arthur Kemmet	1948	90	Drl	100	6	--	Gravel	--	60	D	Water leaves iron stains on porcelain fixtures.
Sa 1042	9Y, 2.1N, 6.7E	Henry Cassler, Sr.	1921	230	Drv	18	1¼	--	Sand	11.3 7/15/58	--	U	Formerly used for saw mill.

Table 1-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 1043	9Y, 1.6N, 5.7E	Henry Schultz	--	290	Drl	100	6	--	Sand	20	--	D	Cistern water used for washing.
Sa 1044	9Y, 1.0S, 7.1E	Myron Hurd	--	100	Dug	20	36	--	do.	16	--	D	Water leaves iron stains on porcelain fixtures.
Sa 1045	9Y, 1.2N, 6.2E	William Doyle	1928±	250	Dug	17	36	--	do.	--	--	U	Well goes dry during dry seasons. Well entered clay at depth of about 7 ft.
Sa 1046	9Y, 1.3N, 5.4E	William Price	--	280	Dug	22	12	---	Till	2.2 5/ 2/58	--	U	When used, well went dry each summer.
Sa 1047	9Y, 0.7N, 6.3E	Alfred Scholtz	1928±	240	Dug	20	24	--	Sand	7	--	D	Yield inadequate in summer of 1957. Family hauled water from "Dakota Spring" (Sa 48 Sp).
Sa 1048	9Y, 0.9N, 5.4E	Irving Hegeman	--	320	Dug	7	36	--	Shale	1.5 4/25/58	--	S	Water contains hydrogen sulfide.
Sa 1049	do.	do.	1946	330	Drl	60	6	3	do.	4.5 4/25/58	9	D	No hydrogen sulfide. Well Sa 1049 is 300 ft west of well Sa 1048.
Sa 1050	9Y, 0.4N, 5.3E	U. S. National Park Service	--	340	Drl	26	6	--	do.(?)	13.5 7/16/58	--	U	
Sa 1051	9Y, 0.3N, 5.3E	do.	--	300	Dug	9	36	--	Till	6.0 4/25/58	--	U	
Sa 1052	9Y, 1.1N, 6.3E	Hollis Barber	--	350	Dug	9	24	--	Shale	2.0 4/25/58	--	U	Goes dry during dry seasons.
Sa 1053	do.	do.	1946±	350	Drl	30	6	--	do.	--	--	D	
Sa 1054	8Y, 16.7S, 4.9E	Edward Lynch	1946	410	Drl	86	6	65	do.	30	5	O	
Sa 1055	do.	do.	--	410	Dug	13	24	--	Till	3.2 4/30/58	--	U	When used, went dry during dry seasons.
Sa 1056	9Y, 0.1N, 4.6E	Charles Britten	--	440	Dug	10	190±	--	do.	1.8 4/30/58	--	U	
Sa 1057	9Y, 0.2N, 4.7E	do.	--	380	Dug	8	48	--	do.	2.5 4/30/58	--	U	
Sa 1058	9Y, 0.6N, 4.0E	James Skellie	1952	400	Drl	145	6	25	Shale	40	10	D,S	Water contains hydrogen sulfide.
Sa 1059	9Y, 1.8S, 5.9E	Roy Sharp	1955	140	Drl	135	6	--	do.	30	4	D	Field determinations of hydrogen sulfide show average content of 2.5 ppm (average based on 3 samples collected 7/30/58 from storage tank while well was being pumped).
Sa 1060	9Y, 0.9S, 7.1E	Glenn Larson	--	100	Dug	15	36	--	Sand	8.3 5/ 5/58	--	D	Yield inadequate in summer 1957.
Sa 1061	9X, 2.5N, 3.6E	Arnol Knickerbocker	--	445	Drl	316	6	174	Shale	15.3 5/24/58	1	O	Dug well Sa 574 located on property.
Sa 1062	9Y, 0.3N, 6.6E	U. S. National Park Service	--	220	Dug	13	30	--	Sand	11.7 6/13/58	--	U	
Sa 1063	9Y, 2.1N, 6.6E	Henry Cassier, Sr.	--	240	Drv	18	2	--	do.	--	--	D	Temp 49.2°F, 7/15/58.
Sa 1065	9Y, 0.1N, 6.7E	U. S. Geological Survey	1958	224.0	Brd	17	1½	--	do.	11.1 8/14/58	--	T,O	BH 13. Finished with 60-gauze screened drive point 3 ft long. Hole bored to depth of 28 ft, backfilled with sand. Sand 0-17, clay 17-28. Water-level fluctuations recorded by U. S. Geological Survey Aug. 1958-Nov. 1959.
Sa 1066	do.	do.	1958	213.8	Brd	9	1½	--	do.	5.2 8/14/58	--	T,O	BH 14. Finished with 60-gauze screened drive point 3 ft long. Hole bored to depth of 23 ft, backfilled with sand. Sand 0-11, clay 11-23. Water-level fluctuations recorded by U. S. Geological Survey Sept. 1958-Nov. 1959.

Table 1-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 1067	9Y, 0.1N, 6.7E	U. S. Geological Survey	1958	227.2	Brd	23	1½	--	Sand	9.6 8/14/58	--	T,O	BH 18. Finished with 60-gauze screened drive point 3 ft long. Hole bored to depth of 33 ft, backfilled with sand. Silt, fine sand 0-7, fine to medium sand 7-16, medium to coarse sand 16-26, clay 26-33. Water-level fluctuations recorded by U. S. Geological Survey Aug. 1958-Nov. 1959.
Sa 1068	do.	do.	1958	229.5	Brd	17	1½	--	do.	9.4 8/14/58	--	T,O	BH 19. Finished with 60-gauze screened drive point 3 ft long. Hole bored to depth of 28 ft, backfilled with sand. Sand 0-21, clay 21-28. Water-level fluctuations recorded by U. S. Geological Survey Aug. 1958-Nov. 1959.
Sa 1069	do.	do.	1958	228.3	Brd	18	1½	--	do.	6.7 8/14/58	--	T,O	BH 22. Finished with 60-gauze screened drive point 3 ft long. Hole bored to depth of 33 ft, backfilled with sand. Sand 0-24, clay 24-33. Water-level fluctuations recorded by U. S. Geological Survey Aug. 1958-Nov. 1959.
Sa 1070	9Y, 0.7N, 2.9E	U. S. Air Force, Air Defense Command	1958	400	Drl	160	12	15	Shale	7.0 9/ 4/58	60	--	Drawdown 90 ft after pumping 60 gpm for 48 hrs. Water contains hydrogen sulfide.
Sa 1071	9X, 4.2N, 3.2E	Andrew Foss	--	540	Drl	122	6	--	Sand and gravel	24	7	D	Coarse sand and boulders 0-70, sand 70-115, gravel 115-122. Drawdown 36 ft after pumping 7 gpm for 2 hrs.
Sa 1072	9Y, 0.1N, 6.7E	U. S. Geological Survey	1959	224.0	Drl	23.8	6	--	Sand	9.8 8/11/59	5	T,D	A 2-inch diamater 30-gauze screened drive point 3 ft long extends 4 ft below the 6-inch casing. The drive point is imbedded in a coarse sand pack. Sand aquifer, 25 ft thick is underlain by clay. Water-level fluctuations recorded by U. S. Geological Survey since Aug. 1959. Wells Sa 1072-Sa 1084 were constructed for use in the pumping test of Aug. 11-13, 1959.
Sa 1073	do.	do.	1959	224.3	J	24.3	2	--	do.	10.2 8/11/59	8	T,O	Drawdown 4.6 ft after pumping 8 gpm for 1½ hrs. The 2-inch observation wells have 60-gauze screened drive points 3 ft long.
Sa 1074	do.	do.	1959	225.2	J	24.4	2	--	do.	11.3 8/11/59	18	T,O	Well pumped at 18 gpm for 17 min. Drawdown 3.5 ft after pumping 8 gpm for 1 hr.
Sa 1075	do.	do.	1959	223.4	J	23.8	2	--	do.	9.1 8/11/59	15	T,D	Well pumped at 15 gpm for 11 min. Drawdown 3.2 ft after pumping 8 gpm for 1 hr.
Sa 1076	do.	do.	1959	223.0	J	23.7	2	--	do.	8.7 8/11/59	15	T,O	Well pumped at 15 gpm for 15 min. Drawdown 3.0 ft after pumping 8 gpm for 1 hr.
Sa 1077	do.	do.	1959	223.7	J	24.1	2	--	do.	9.4 8/11/59	35	T,O	(b). Well pumped at 35 gpm for 10 min and then 30 gpm for 20 min. Drawdown 4.69 ft after pumping 17.2 gpm for 2 days. Equipped with a 60-gauze screened drive point 5.5 ft in length. Temp 50.2°F, 8/13/59 after 2 days pumping. Step-drawdown test performed on well, April 29, 1960. See section in Part III on "Quantitative Studies."
Sa 1078	do.	do.	1959	227.2	J	27.5	2	--	do.	13.7 8/11/59	30	T,O	Well pumped at 30 gpm for 11 min.
Sa 1079	do.	do.	1959	225.2	Drv	14.0	1¼	--	do.	11.3 8/11/59	4	T,O	Finished with 1¼-inch diamater 60-gauze screened drive point 30 inches long.
Sa 1080	do.	do.	1959	224.7	Drv	13.4	1¼	--	do.	10.6 8/11/59	3	T,O	Do.
Sa 1081	do.	do.	1959	224.0	Drv	12.8	1¼	--	do.	9.8 8/11/59	4	T,O	Do.
Sa 1082	do.	do.	1959	223.7	Drv	12.5	1¼	--	do.	9.4 8/11/59	4	T,O	Do.
Sa 1083	do.	do.	1959	223.4	Drv	11.8	1¼	--	do.	9.1 8/11/59	4	T,O	Do.
Sa 1084	do.	do.	1959	223.0	Drv	11.4	1¼	--	do.	8.6 8/11/59	4	T,O	Do.

Recorder

Table I-3.--Records of selected wells and test holes in Saratoga County (Continued)

Well number	Location	Owner or occupant	Date completed	Altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter (inches)	Depth to bedrock (feet)	Water-bearing material	Water level below land surface (feet)	Yield (gallons per minute)	Use	Remarks
Sa 1085	9Y, 0.1N, 6.7E	U. S. Geological Survey	1960	223.7	Drv	24.0	$1\frac{1}{4}$	--	Sand	6.6 4/29/60	5	T,O	Finished with $1\frac{1}{4}$-inch diameter 60-gauze screened drive point 3 ft long.
Sa 1086	do.	do.	1960	223.6	Drv	23.4	$1\frac{1}{4}$	--	do.	6.4 4/29/60	5	T,O	Do.
Sa 1087	do.	do.	1960	223.8	Drv	10.4	$1\frac{1}{4}$	--	do.	6.7 4/29/60	5	T,O	Do.
Sa 1088	do.	do.	1960	224.1	Drv	10.0	$1\frac{1}{4}$	--	do.	7.0 4/29/60	5	T,O	Finished with $1\frac{1}{4}$-inch diameter 60-gauze screened drive point 30 inches long.

PART II

GEOLOGY AND GROUND-WATER RESOURCES OF THE WEST MILTON AREA

By

Frederick K. Mack

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PART II

GEOLOGY AND GROUND-WATER RESOURCES OF THE

WEST MILTON AREA

By Frederick K. Mack

INTRODUCTION

In 1948, the United States Government acquired approximately 4,000 acres of land in the West Milton area of Saratoga County as a site for a reactor research installation of the Atomic Energy Commission. The installation is an adjunct of the Knolls Atomic Power Laboratory at Schenectady.

Use of the site for reactor research has presented certain geologic and hydrologic problems. Among these have been:

1. The availability of water to supply the installation.

2. The foundation conditions that would be encountered in the construction of buildings.

3. The suitability of the area for the disposal of radioactive wastes.

4. The location of gravel for use in road building and other construction work.

At the request of the Schenectady Operations Office, U. S. Atomic Energy Commission, studies of these problems were undertaken by the Water Resources Division of the U. S. Geological Survey. Many of the geologic and ground-water studies for this investigation were carried out by E. S. Simpson of the U. S. Geological Survey during the years 1949-54. Some additional field work was done during the years 1955-57 by the author and other personnel of the Albany office of the Ground Water Branch.

This part of the report on ground-water studies in Saratoga County consists of a brief description of those results of the investigation that are of general interest to residents of the county. A more complete report on the geology and hydrology of the area (Mack, Pauszek, and Crippen) is now in preparation for publication in the series of Water-Supply Papers of the U. S. Geological Survey.

Acknowledgments

J. G. Broughton, State geologist; D. W. Fisher, State paleontologist; and other geologists of the Geological Survey, New York State Museum and Science Service, provided valuable assistance and advice regarding the geology of the area. The Bureau of Soil Mechanics, New York State Department of Public Works, made seismic surveys to determine the depth to bedrock at 24 sites in the area. Well data were furnished by: Stewart Brothers,

Schenectady, N. Y.; B. Uhlinger, Amsterdam, N. Y.; R. G. Voehringer, Ballston Spa, N. Y.; and R. E. Chapman Co., Oakdale, Mass.

Data from six programs of test-well and test-hole drilling at locations on the government reservation have been utilized and freely drawn upon in the preparation of this report. These programs, which were carried out for the Atomic Energy Commission, include drilling by (1) the Corps of Engineers, U. S. Army, in 1948; (2) Raymond Concrete Pile Company in 1950; (3) Pennsylvania Drilling Company, Pittsburgh, Pa., in 1952; (4) Stewart Brothers, Schenectady, N. Y., in 1955 and 1956; and (5) R. E. Chapman Company, Oakdale, Mass., in 1957.

Land owners and other individuals in the area furnished data regarding their wells and water supplies.

GEOGRAPHY

Location

The West Milton area is in the southwestern part of Saratoga County (fig. I-2). As used in this report, the area consists of a government-owned reservation of 4,000 acres and the adjoining area (fig. II-4). The area generally lies between latitude 43°00'N. and 43°05'N. and longitude 73°55'W. and 74°00'W. It is located about 17 miles north of the city of Schenectady and about 9 miles southwest of the city of Saratoga Springs. Ballston Spa, a small incorporated village, is located in the southeastern corner of the area.

Topography and Drainage

The West Milton area consists of a series of irregular northeast-trending topographic steps which extend in a southeasterly direction from the Kayaderosseras Range, a group of low hills that separate the Adirondack Mountains on the northwest from the Hudson lowland on the southeast. The steps are generally less than a mile wide and become progressively higher toward the Kayaderosseras Range. They appear to be controlled, at least in part, by a series of normal faults that parallel the front of the range. The positions of these faults can be seen in figure I-4 and in figure II-1. The surface of each step is marked by low rounded northeast-southwest elongated hills most of which are composed of unconsolidated deposits. Where Glowegee Creek, Crook Brook, and other streams draining the area cross the scarps separating the different steps, their valleys are relatively narrow and steep sided. On the steps, stream valleys are generally broad and less well defined.

Altitudes in the area range from about 400 feet above sea level along Kayaderosseras Creek to about 900 feet along the southeast flank of the Kayaderosseras Range. The steepest slopes in the area are generally found along the southeast side of the hills that border the scarps. In places, local relief is as much as 50 feet in the horizontal distance of 100 feet.

The area is drained by Glowegee Creek and Crook Brook, tributaries of Kayaderosseras Creek. The major streams draining the area are shown in figure II-4. Kayaderosseras Creek heads about 12 miles north of West Milton (fig. I-3) and flows in a southerly direction generally parallel to the Kayaderosseras Range. Near West Milton, it turns and flows in an easterly

direction for a distance of about 10 miles where it empties into Saratoga Lake. The overflow of Saratoga Lake passes through Fish Creek into the Hudson River.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES

Rock formations underlying the West Milton area are of two major types: (1) consolidated rocks which range in age from Precambrian to Ordovician, and (2) unconsolidated deposits of Pleistocene and Recent age. The distribution of the bedrock formations in the area is shown in figure II-1. These rocks underlie the entire area and crop out on some steep hillsides and in some stream valleys. They are covered by the unconsolidated deposits in the remainder of the area. The unconsolidated deposits range in thickness from a few feet in the lower parts of some stream valleys to more than 200 feet in a buried valley that crosses the eastern part of the government-owned reservation. The unconsolidated deposits in an area centered around the reservation are shown in figure II-5.

Consolidated Rocks

The consolidated rocks underlying the West Milton area may be divided into two groups; (1) metamorphosed rocks of Precambrian age, and (2) unmetamorphosed rocks of Paleozoic age. The older, the metamorphosed rocks of Precambrian age, are made up of gneiss, schist, quartzite, and limestone (marble) of sedimentary origin, and syenite and granite of igneous origin (Cushing and Ruedemann, 1914, p. 16 and 17). These rocks are referred to as crystalline rocks in Part I and in figure I-4. The Paleozoic rocks likewise consist of several types including sandstone, dolomite and limestone (carbonate rocks), and shale. Brief descriptions of the consolidated rocks are given in Part I and in table II-1.

Structure

The West Milton area is located in a region of major faulting which extends from south of the Mohawk River northeastward along the southeastern border of the Adirondack Mountains. All the major faults in this region are of the normal type with displacements ranging from about 100 feet to more than 1,500 feet. In all cases, the area west of each fault moved upward relative to the area east of the fault. Generally the faults strike northeast and have steep angles of dip. The age of the faults is not precisely known but they are ancient and probably sealed in many places by secondary mineralization.

The two most prominent faults in the West Milton area, the East Galway fault and the West Galway fault, are branches of the well-known Hoffmans Ferry fault. This fault has been traced for 40 miles through the region from Hoffmans, on the Mohawk River, to Fort Ann, about 10 miles northeast of South Glens Falls. Movements along the East Galway, West Galway, and the Rock City Falls faults have resulted in the distinctive outcrop pattern shown in figure II-1. Some of the more prominent faults in the county are shown in figure I-4.

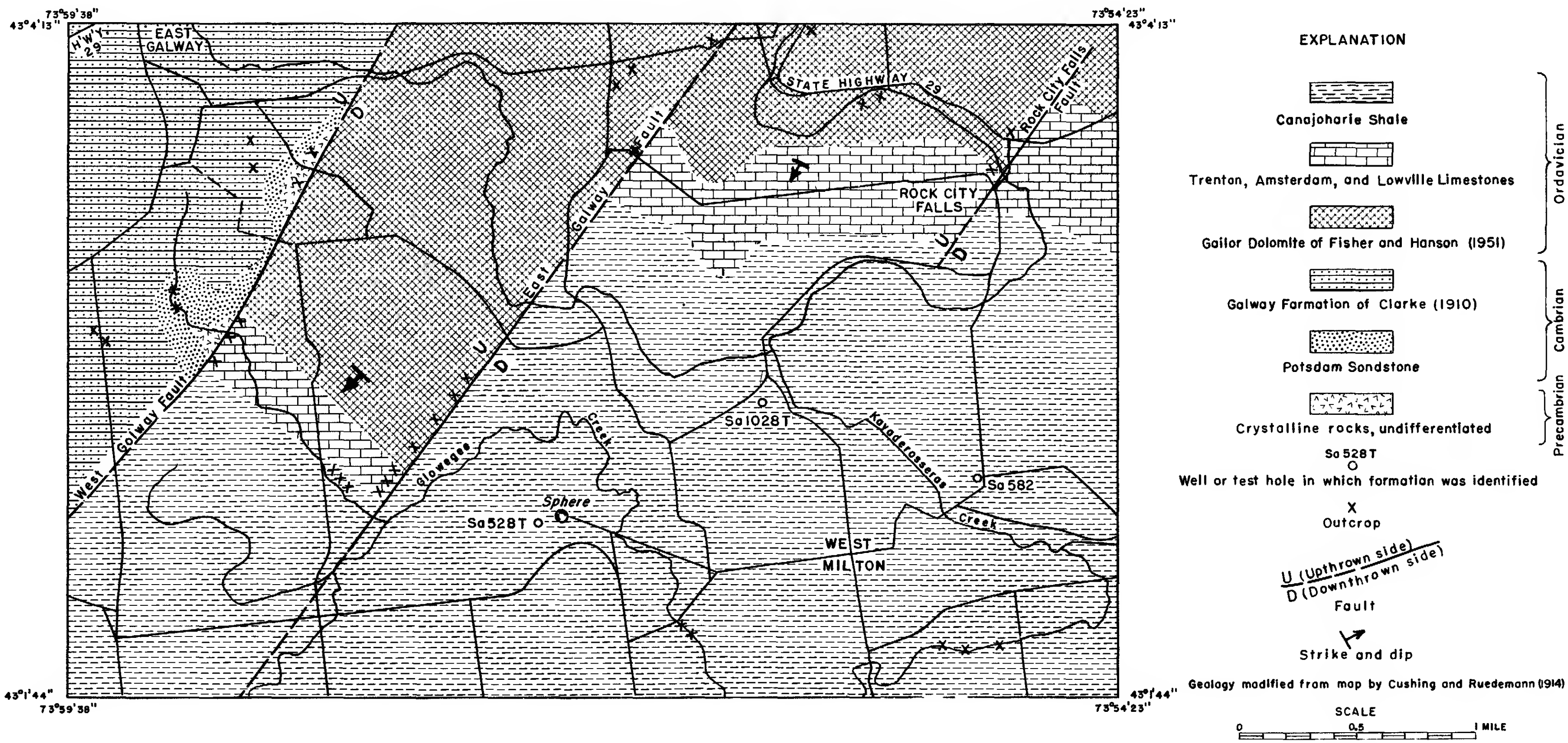

Figure II-1.--Map of the West Milton area showing the areal distribution of bedrock formations.

Table II-1.--Rock formations in the West Milton area and their water-bearing properties

Designation used in Part I	Class	System	Age	Formation	Thickness (feet)	Character of material	Water-bearing properties
Sand and gravel	Unconsolidated deposits	Quaternary	Recent	Alluvium	0- 20	Clay, silt, sand, and gravel deposited by present-day streams.	Not important as source of water because of limited extent and thickness. Restricted to discontinuous areas adjacent to streams.
Sand and gravel	Unconsolidated deposits	Quaternary	Pleistocene	Stratified deposits: Deltas, kames, and flood-plain deposits	0- 80	Irregular, interbedded, and interlensing deposits of sand and gravel deposited by glacial melt-water streams.	Most productive water-bearing deposit in the area. Comprises the aquifers from which the supply of the Atomic Energy Commission installation at West Milton is obtained. Yields moderate supplies to many shallow domestic wells in sand plain areas near Ballston Spa. In places, these deposits are capable of yielding several hundred gallons of water per minute to screened wells.
Clay and silt	Unconsolidated deposits	Quaternary	Pleistocene	Stratified deposits: Lake-bottom deposits	0-125	Clay, silt, and fine sand deposited in glacial lakes.	Yield little water. Generally act as confining bed where underlain by permeable deposits.
Till	Unconsolidated deposits	Quaternary	Pleistocene	Unstratified drift: Till	0-150	Heterogeneous mixture of boulders, gravel, sand, and clay deposited by glacial ice. Local drillers call compact till "hardpan."	Underlies relatively large parts of the area. Will yield small supplies of water to large-diameter dug wells.
Shale	Consolidated rocks	Ordovician	Middle Ordovician	Canajoharie Shale	500+	Soft, black, carbonaceous, more or less calcareous, splintery shale.	Most extensive bedrock formation in the area. Yield of wells averages about 7 gpm a/. Water from some wells contain hydrogen sulfide.
Carbonate rocks	Consolidated rocks	Ordovician	Middle Ordovician	Trenton, Amsterdam, and Lowville Limestones	55	Trenton - Thin bedded, fine-grained, blue-black fossiliferous limestone containing thin layers of shale. Thickness about 50 ft. Amsterdam - Thick bedded, blue-black limestone. Thickness 0-3 ft. Lowville - Fine-grained, gray limestone. Thickness 0-1 ft.	Underlies only a small part of the area. Not important as a source of water.
Carbonate rocks	Consolidated rocks	Ordovician	Lower Ordovician	Gailor Dolomite of Fisher and Hanson (1951)	150	Massive beds of dark-gray, rarely fossiliferous dolomite, largely fine grained. Contains black to dark-gray chert nodules and vugs lined with dolomite, calcite, and quartz.	Yield of wells averages about 30 gpm a/. Supplies large quantities of water to areas north and east of city of Saratoga Springs. Yields mineral water at Saratoga Springs.
Sandstone	Consolidated rocks	Cambrian	Upper Cambrian	Galway Formation of Clarke (1910)	120	Alternating sandy dolomites, dolomitic sandstones, and calcareous sandstones. Sandstones most abundant in lower part of formation and dolomite most abundant in the upper part.	Yield of wells averages about 20 gpm and depth of wells averages about 45 ft a/.
Sandstone	Consolidated rocks	Cambrian	Upper Cambrian	Potsdam Sandstone	50-100	Siliceous sandstone in lower half with occasional beds of calcareous sandstone. Upper 50 ft is more calcareous with occasional beds of blue sandy dolomite.	Yield of wells averages about 10 gpm and depth of wells averages about 67 ft a/.
Crystalline rocks	Consolidated rocks	Precambrian	Precambrian	Crystalline rocks undifferentiated	Unknown	Highly metamorphosed sediments; gneisses, schists, quartzites, and limestones which have been intruded by syenites and granites.	Yield of wells averages about 6 gpm a/.

a/ Information based on records of selected wells from the entire county.

Bedrock Topography

Previous work on the topography of the bedrock surface in the area was done by Cushing and Ruedemann (1914, p. 12 and 13, and accompanying geologic map) during their investigation of the geology of the Saratoga and Schuylerville quadrangles. On the basis of topographic evidence and data from bedrock outcrops, they concluded that the northern part of Kayaderosseras Creek follows the valley of a preglacial stream which drained a much larger part of the southeastern Adirondack Mountains than Kayaderosseras Creek now drains. Because this valley in the West Milton area is filled with unconsolidated materials which were deposited during the Pleistocene Epoch, Cushing and Ruedemann were unable to determine its exact location. However, they indicated on their geologic map that the valley curves to a southerly direction about 2 miles northwest of Middle Grove (fig. I-3) and passes about 1 mile east of West Milton.

The present investigation of the bedrock topography of the area utilized data obtained from (1) bedrock mapping, (2) wells and test holes, and (3) seismic studies. These data are summarized in figures II-2 and II-3 which show the altitude of the top of bedrock in the West Milton-Rock City Falls area. The configuration of the bedrock surface in the area is irregular - probably more irregular than the land surface. The contours on the bedrock surface in figure II-2 are generalized owing to the lack of detailed data and therefore they do not reflect minor irregularities in the bedrock surface. This is substantiated by figure II-3 which shows that the top of the bedrock in the vicinity of the sphere 1/ is actually considerably more irregular than would be suggested by the contours in figure II-2. Total relief of the bedrock surface in the area shown in figure II-2 is at least 450 feet and may be as much as 550 feet. A comparison of the contours on the land surface with those on the top of the bedrock shows that the character of the underlying bedrock surface cannot be predicted on the basis of the land-surface topography alone.

Figure II-2 shows that the bedrock surface in the northwestern part of the West Milton-Rock City Falls area declines relatively steeply along a northeast-southwest trending scarp from an altitude of about 650 feet to an altitude of about 450 feet. A comparison of the geologic map in figure II-1 with figure II-2 shows that this scarp coincides with the East Galway fault. Southeast of the scarp, the principal irregularities appear to be valleys which were eroded into the bedrock in preglacial or glacial time.

Section B-B' of figure II-2 shows that one of these valleys crosses Armer Road in a north-south direction about 1 mile south of Hatch Bridge. The data available on the extent of this valley and on the configuration of the bedrock surface in the eastern part of the area are not sufficient to indicate whether the valley is a continuation of the preglacial valley followed by Kayaderosseras Creek north of Middle Grove or merely a tributary to it. It is doubtful on the basis of its relatively narrow width, that this valley was cut by a large stream such as would be required to drain the southeastern part of the Adirondack Mountains. Therefore, it is probable

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1/ The sphere, the most conspicuous landmark in the area, is a steel shell 225 feet in diameter constructed by the Atomic Energy Commission to house atomic reactors.

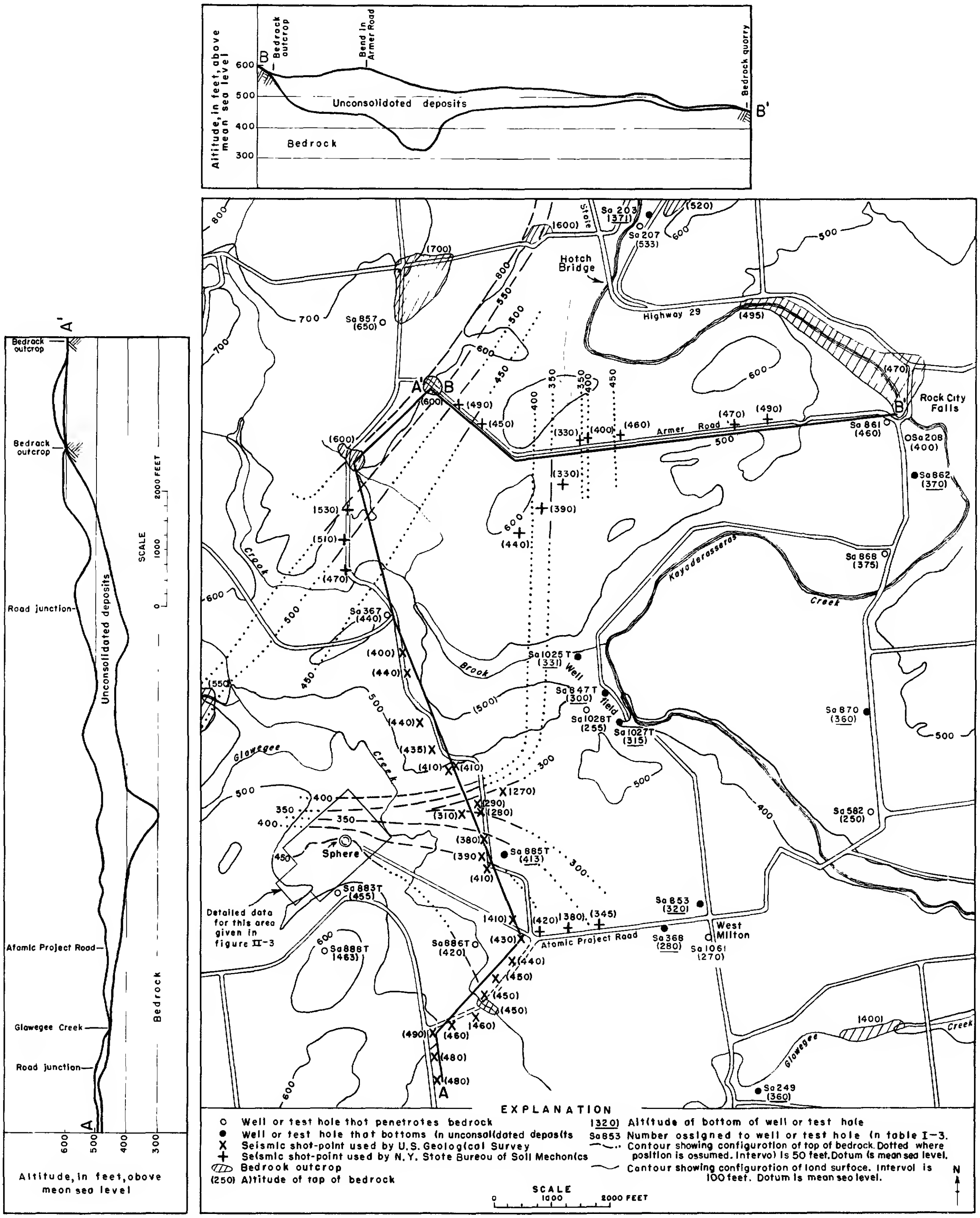

Figure II-2.--Map of the West Milton-Rock City Falls area showing the altitude of the top of bedrock. (after Mack and others, fig. 4)

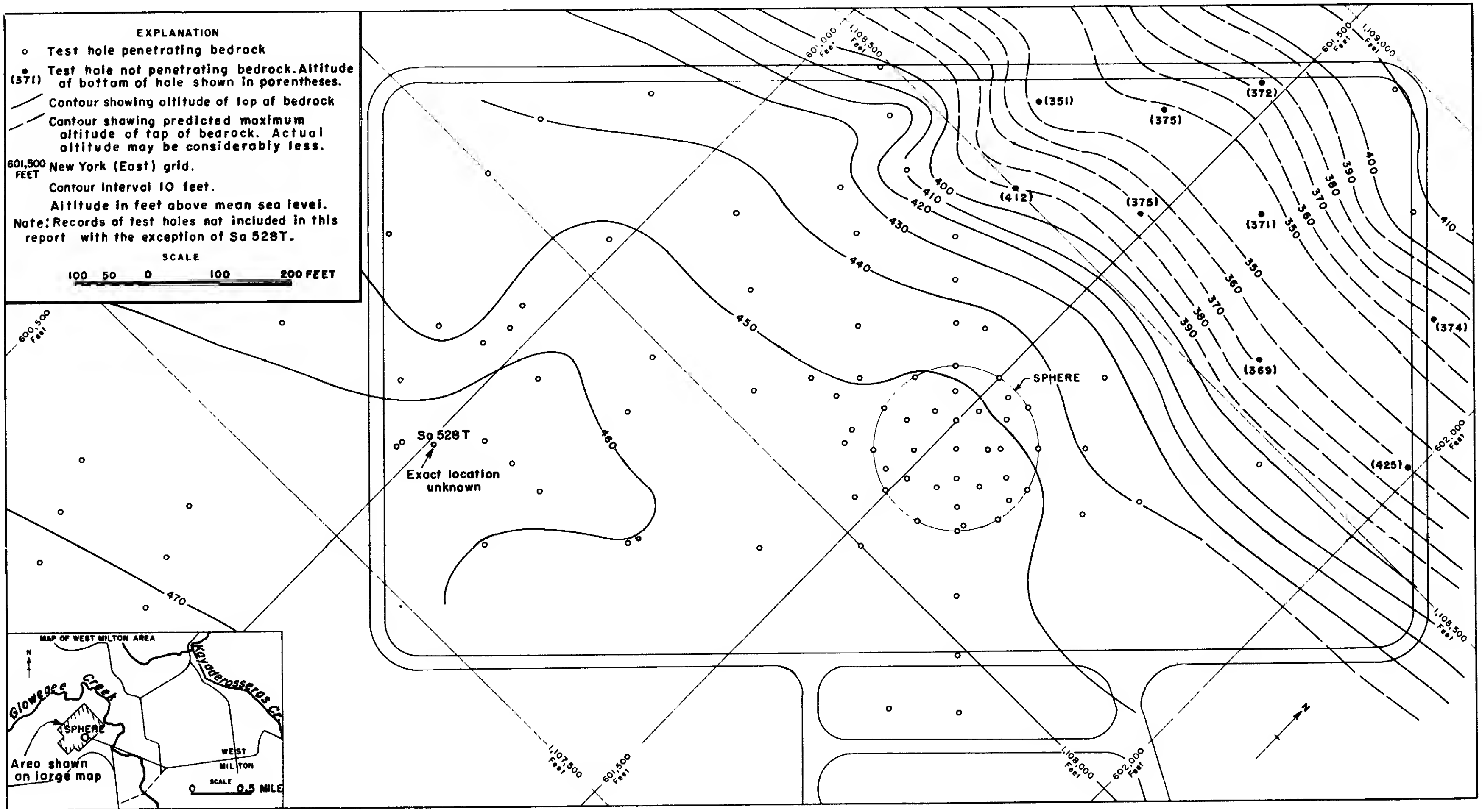

Figure II-3.--Map of the West Milton reactor site showing the altitude of the top of bedrock.

that this valley was cut by a tributary to the preglacial stream described by Cushing and Ruedemann.

Figure II-2 shows that the valley described above is joined about 1 mile northwest of the hamlet of West Milton by a small tributary valley which extends in an east-west direction a few hundred feet north of the sphere. This valley, where crossed by section A-A' of figure II-2 is relatively narrow and is entrenched to a depth of about 100 feet in bedrock. Figure II-3 which is based on test-hole data, shows that the axis of this valley is located approximately 500 feet north of the sphere and that the surface of bedrock at the sphere slopes downward to the north toward the axis of the valley. The western extent of this valley has not been determined.

Water-bearing Characteristics

Where the consolidated rocks are not exposed at the surface, they underlie the area at depths ranging from less than a foot near outcrops to more than 200 feet near the eastern end of the buried valley west of Kayaderosseras Creek. All these rocks are dense and compact, and the movement and storage of ground water in them are controlled by joints, faults, and other openings.

The spacing of these openings is irregular, ranging from a few inches to several feet. Except for joints in limestones and other soluble rocks which have been enlarged by solution, openings along joints are generally less than 0.1 inch wide.

The locations of selected wells in the area that draw from consolidated rocks are shown in figure II-4. No wells in the area are known to draw water from the crystalline rocks exposed along the West Galway fault. (See figure II-1.) However, records of wells drawing from these rocks in other parts of the county indicate that their yield averages only about 6 gpm (table I-2). Similarly, no wells in the area tap the Potsdam Sandstone but records of wells in other parts of the county indicate a yield of about 10 gpm. (See table II-1.) Only one well shown in figure II-4, well Sa 271, taps the Galway Formation of Clarke (1910) but the yield of the well was not reported. The yield of the other wells in the county tapping this formation is about 20 gpm. Although the Galway Formation is predominantly dolomite along the contact with the younger formations shown in figure II-1, the yields of wells tapping it have been included with the sandstone in table I-2. This was done because the sandy character of the formation as a whole serves to distinguish it from the overlying generally sand-free dolomites and limestones. The relatively thick section of carbonate rocks, including the Gailor Dolomite of Fisher and Hanson (1951), and Trenton, Amsterdam, and Lowville Limestones, are the most productive bedrock formations in the area. The relatively high yield of these formations, which averages about 31 gpm (table I-2) is doubtless due principally to the enlargement of joints and other openings through solution.

The Canajoharie Shale, which underlies more than 50 percent of the area, supplies water to several wells. The yield of these wells ranges from less than 5 gpm to about 50 gpm and averages about 7 gpm. The yield of wells drawing from the shale in the county as a whole averages about 9 gpm (table I-2). Several of the test holes drilled to determine founda-

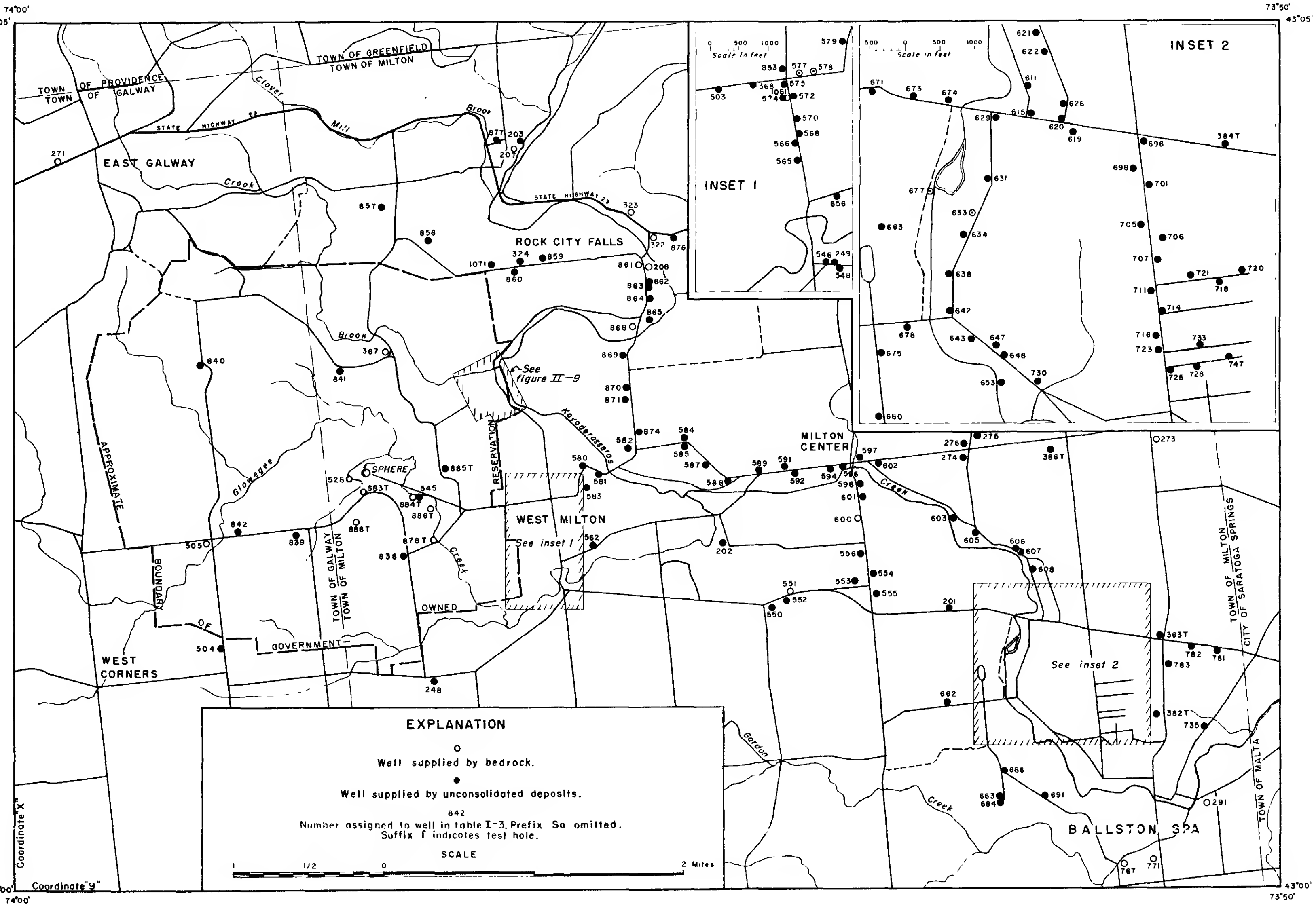

Figure II-4.--Map of the West Milton area showing the location of selected wells and test holes.

tion conditions and to locate a water supply for the Atomic Energy Commission penetrated the shale. The deepest of these, test hole Sa 528T, passed through approximately 500 feet of the formation before penetrating the underlying limestone. At a depth of 580 feet, the hole was test pumped for 7 hours at a rate of about 17 gpm with a drawdown of 250 feet. The hole was again test pumped at a depth of 675 feet without any detectable increase in yield. Although the yield of test hole Sa 528T was not determined until it reached a depth of 580 feet, probably most, if not all, of the water produced by the well was derived from the upper part of the shale.

Unconsolidated Deposits

Figure II-5 shows the character of the unconsolidated deposits in a small part of the area centered around the government-owned reservation. The principal types of unconsolidated deposits underlying the remainder of the area are shown in figure I-3.

Several types of unconsolidated deposits overlie the consolidated rocks in the West Milton area (fig. II-5). These deposits range in thickness from zero, in places where bedrock crops out, to more than 200 feet beneath the hills west of Kayaderosseras Creek. The average thickness of the deposits in the area is on the order of 50 feet or more. The unconsolidated deposits can be subdivided into: (1) till - an unstratified mixture of rock particles ranging in size from clay to boulders; (2) kames - irregularly stratified deposits consisting of alternating layers of sand and gravel; (3) flood-plain deposits - generally horizontal imperfectly stratified layers of clay, silt, and fine sand; (4) lake-bottom deposits - horizontally stratified layers of clay, silt, and fine sand; and (5) deltas - relatively homogeneous deposits of fine to coarse sand. The flood-plain deposits and lake-bottom deposits are collectively referred to as clay and silt in Part I and in figure I-3. The kames and deltas are a part of the deposits referred to in Part I as sand and gravel. Figure II-6 is a graph showing the particle size distribution in samples collected from some of these deposits.

The relative position and the thickness of each of the different unconsolidated deposits underlying the West Milton area are shown on the two generalized sections in figure II-5. Many of the data for these sections were obtained from test-well drilling programs conducted in the vicinity of Glowegee and Kayaderosseras Creeks. Detailed geologic sections of the materials penetrated by the test wells are shown in figures II-7 and II-8. As may be observed from the sections in figure II-5, the deposits were laid down in a more or less regular sequence. The lowermost, and thus the oldest, consists predominantly of a relatively thick section of fine-grained (lake-bottom) sediments which overlie bedrock in the buried valley near the sphere and in the valley of Kayaderosseras Creek. Between layers of these fine-grained deposits is a mass of sediments composed of medium to coarse sand containing some gravel. These coarser sediments (which comprise the artesian aquifer shown in figure II-7) appear to have formed as a delta in the same lake in which the finer-grained lake-bottom deposits accumulated. In the valley of Kayaderosseras Creek the lake-bottom deposits are overlain by approximately 25 feet of coarse-grained flood-plain deposits. West of the creek valley, the lake-bottom deposits are overlain by till. Near the sphere. this till directly overlies bedrock. The till is in turn overlain by a second series of lake-bottom deposits at the reactor site and by kames in several other parts of the area.

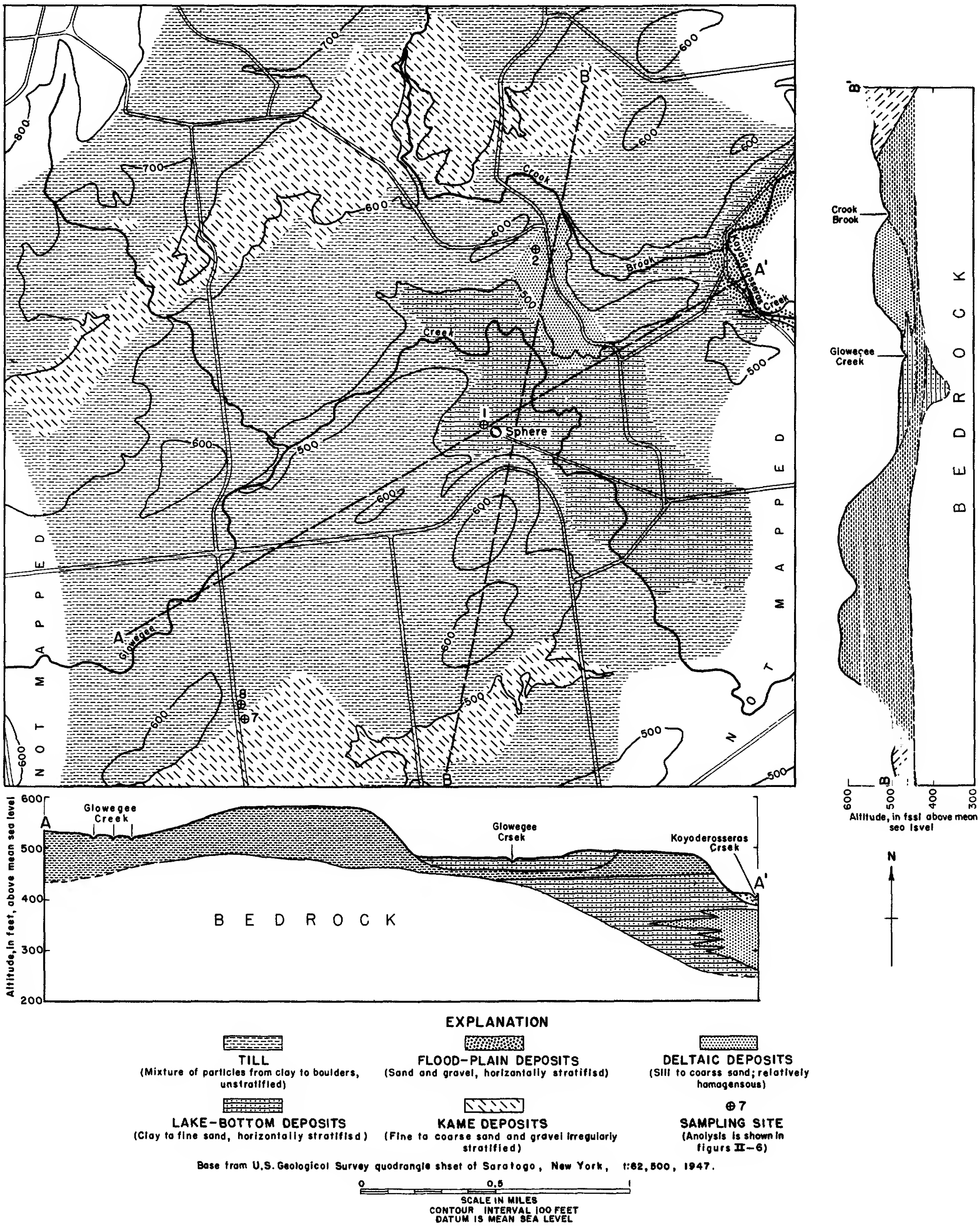

Figure II-5.--Map and geologic sections showing unconsolidated deposits in a part of the West Milton area. (after Mack and others, fig. 6)

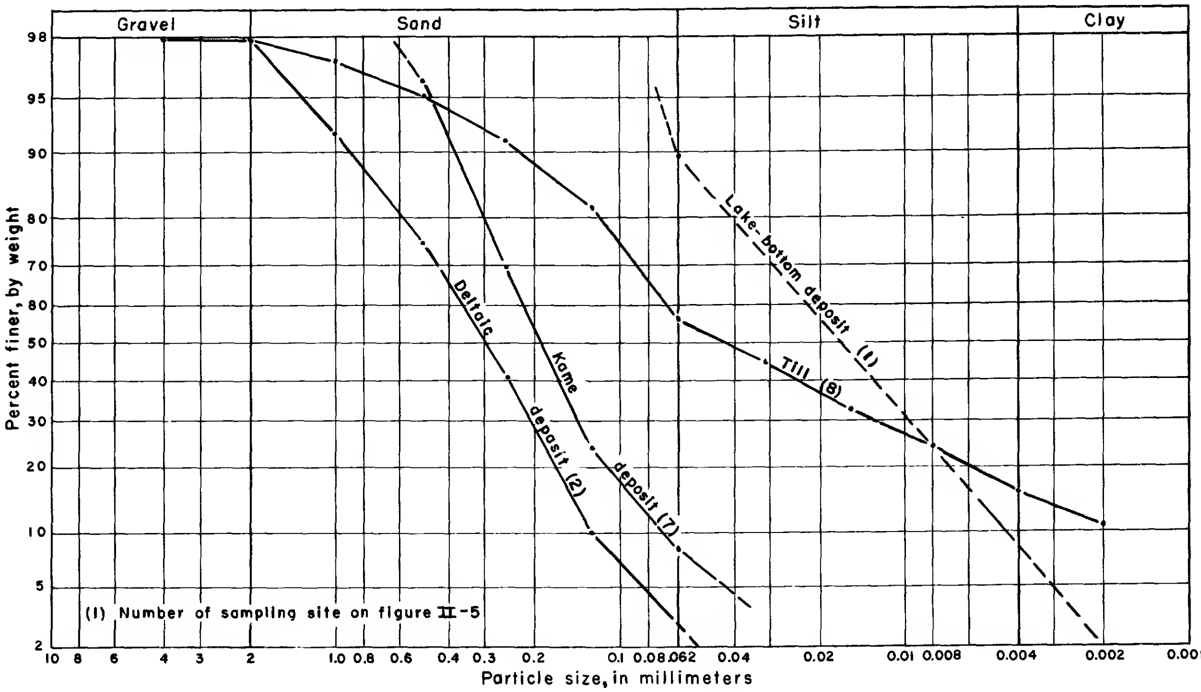

Figure II-6.--Log-normal graphs showing particle-size distribution of samples of till, kame, lake-bottom, and deltaic deposits.

Water-bearing Characteristics

Water occurs in the unconsolidated deposits in the pore spaces between individual grains. The porosity, or percentage of the total volume occupied by pores, differs widely among the different unconsolidated deposits. The till has the lowest porosity of any of the deposits in the area. On the basis of porosity determinations made in other areas, it appears safe to assume that the porosity of the till ranges from about 5 percent to about 15 percent. The porosity of the other deposits doubtless varies widely depending on the degree of sorting. The porosity of these deposits generally ranges from as little as 20 percent to as much as 40 percent.

The permeability of the unconsolidated deposits, and consequently the yield of wells tapping the deposits, is largely dependent on the size of the interconnected openings. The till, lake-bottom, and flood-plain deposits contain a relatively high proportion of silt and clay. Thus, the interconnected openings in these deposits are generally small and the permeability of the deposits is low. Most wells drawing from these deposits are large-diameter dug wells which provide a large area for the infiltration of water and a large volume for storage. The kame and deltaic deposits, on the other hand, are composed of fairly well-sorted and coarse-grained materials. Both of these deposits are capable of yielding moderate to large quantities of water to properly developed, screened wells.

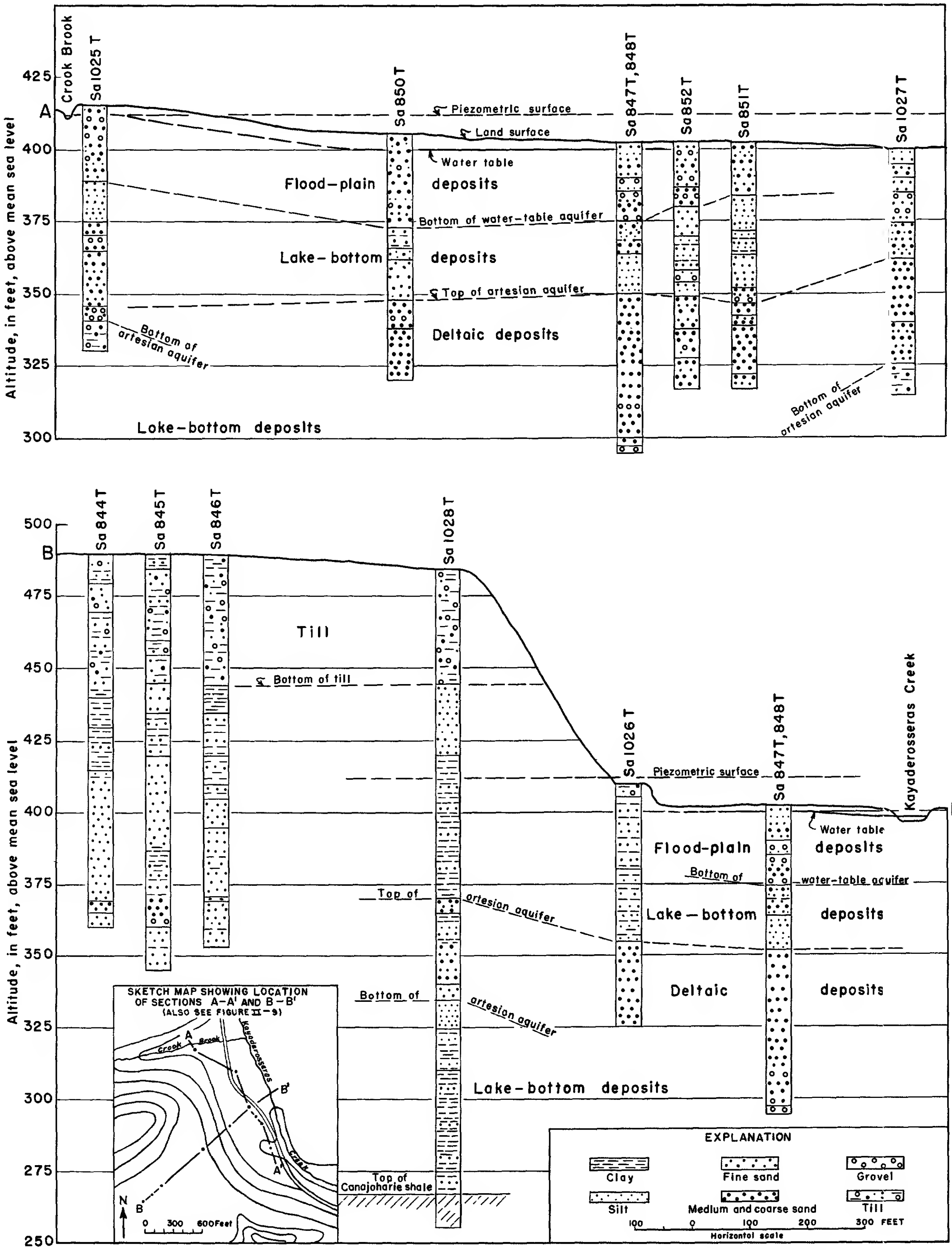

Figure II-7.--Geologic sections showing the materials penetrated by test holes in the vicinity of Kayaderosseras Creek.

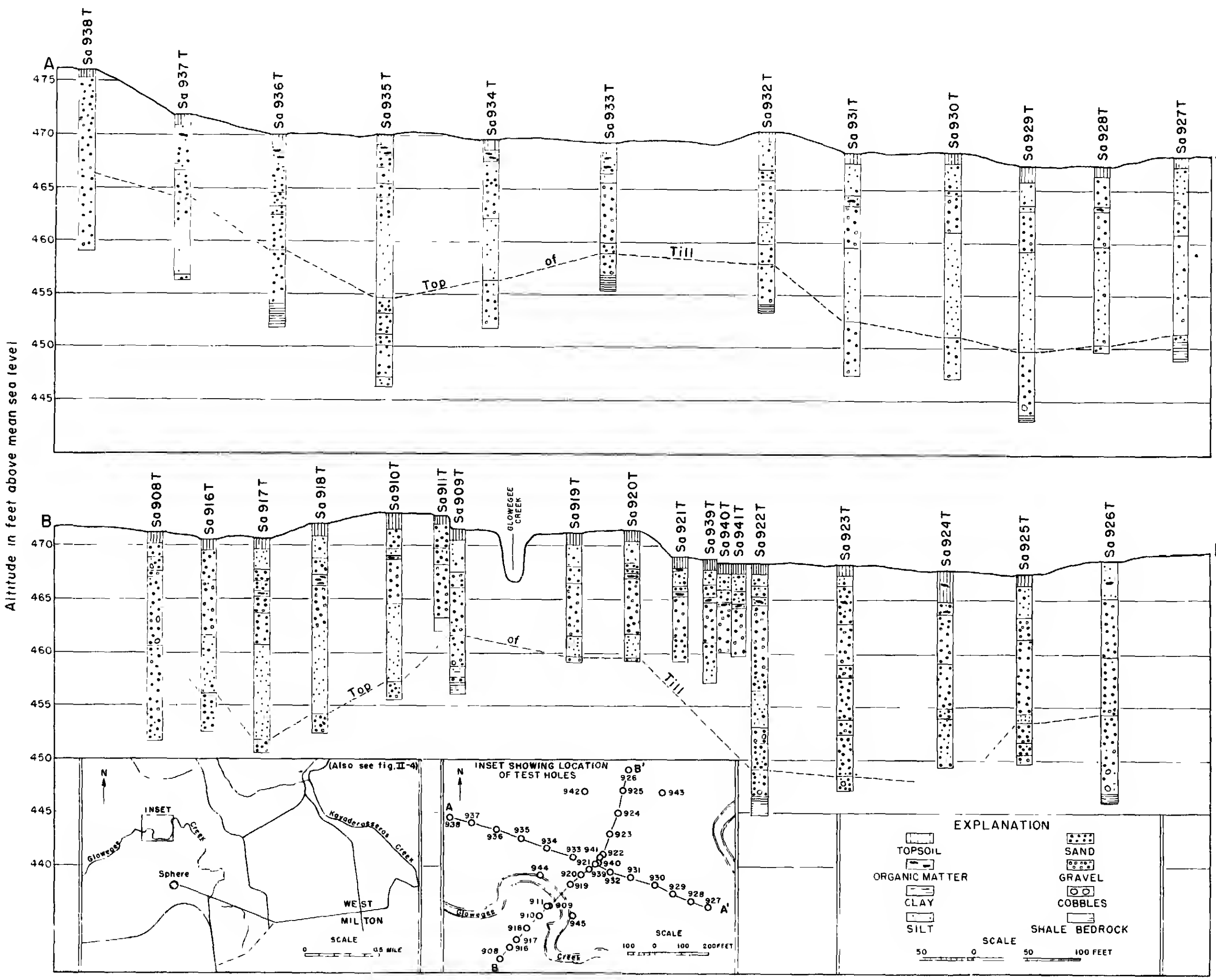

Figure II-8.--Geologic sections showing the materials penetrated by test holes in the vicinity of Glowegee Creek. (Records for these test holes are not included in table I-3, "Records of selected wells and test holes.")

Relatively large yields also may be obtained from the flood-plain deposits from specially constructed wells. The initial water supply of the Atomic Energy Commission installation in the West Milton area was obtained from well Sa 843 (fig. II-9). This well, which is located about 25 feet west of Kayaderosseras Creek, draws from the flood-plain deposits and has been pumped at a rate of 750 gpm for extended periods of time.

The deltaic deposit in the valley of Kayaderosseras Creek comprises the most productive aquifer in the area. Studies of this deposit show that it is capable of yielding as much as 800 gpm to a single screened well. A relatively detailed discussion of these studies and of the water-bearing characteristics of the deposit is contained in the section entitled "Occurrence of ground water in the valley of Kayaderosseras Creek."

Water in the unconsolidated deposits occurs principally under water-table conditions although in parts of the Kayaderosseras Creek valley (and possibly in other areas where sand and gravel deposits are overlain by lake-bottom deposits, till, and other relatively impermeable sediments) the water is under artesian conditions. The water in the deltaic deposits in the valley of Kayaderosseras Creek is, for instance, under sufficient pressure to rise to a height of as much as 12 feet above land surface.

In most of the West Milton area, ground water in unconsolidated deposits probably moves parallel to the topographic slope. However, exceptions to this may occur in the buried valleys which have been described in the section on bedrock topography. The relationship of these valleys to ground-water movement is described in the following sections.

Springs are relatively abundant in the area and some are used as sources of supply. The springs are situated on hillsides or in valley areas and appear to rise from sand and gravel at contacts with underlying less permeable deposits.

OCCURRENCE OF GROUND WATER IN THE VALLEY OF KAYADEROSSERAS CREEK

An important phase of the studies in the West Milton area was concerned with the development of a water supply for the reactor installation. Although all these studies were made at sites on the government-owned reservation, some of the results are applicable to other parts of the area and, to a lesser extent, to other parts of the county. The principal results of the studies are described in the following sections. A more complete discussion will appear in a report now in preparation.

The valley of Kayaderosseras Creek near the confluence of Crook Brook is underlain by a section of unconsolidated deposits approximately 125 feet thick (fig. II-7). The upper 25 feet of the deposits consist of interbedded fine to coarse sand and a few thin layers of gravel. In the interval from 25 to 50 feet below the surface the materials are principally silt with a few layers of fine to coarse sand and, principally toward the western margin of the valley, some clay. In the interval from 50 to about 100 feet below the surface the unconsolidated deposits consist of medium to coarse sand and a few layers of gravel. (See graphic log for wells Sa 847 and Sa 848 in section A-A' in figure II-7.) The character of the lowermost unconsolidated deposits on the flood plain of the creek is known from only two wells, Sa 1025T and Sa 1027T. In well Sa 1025T the deposits appeared to be till whereas in well Sa 1027T they appeared to be interbedded clay and sand.

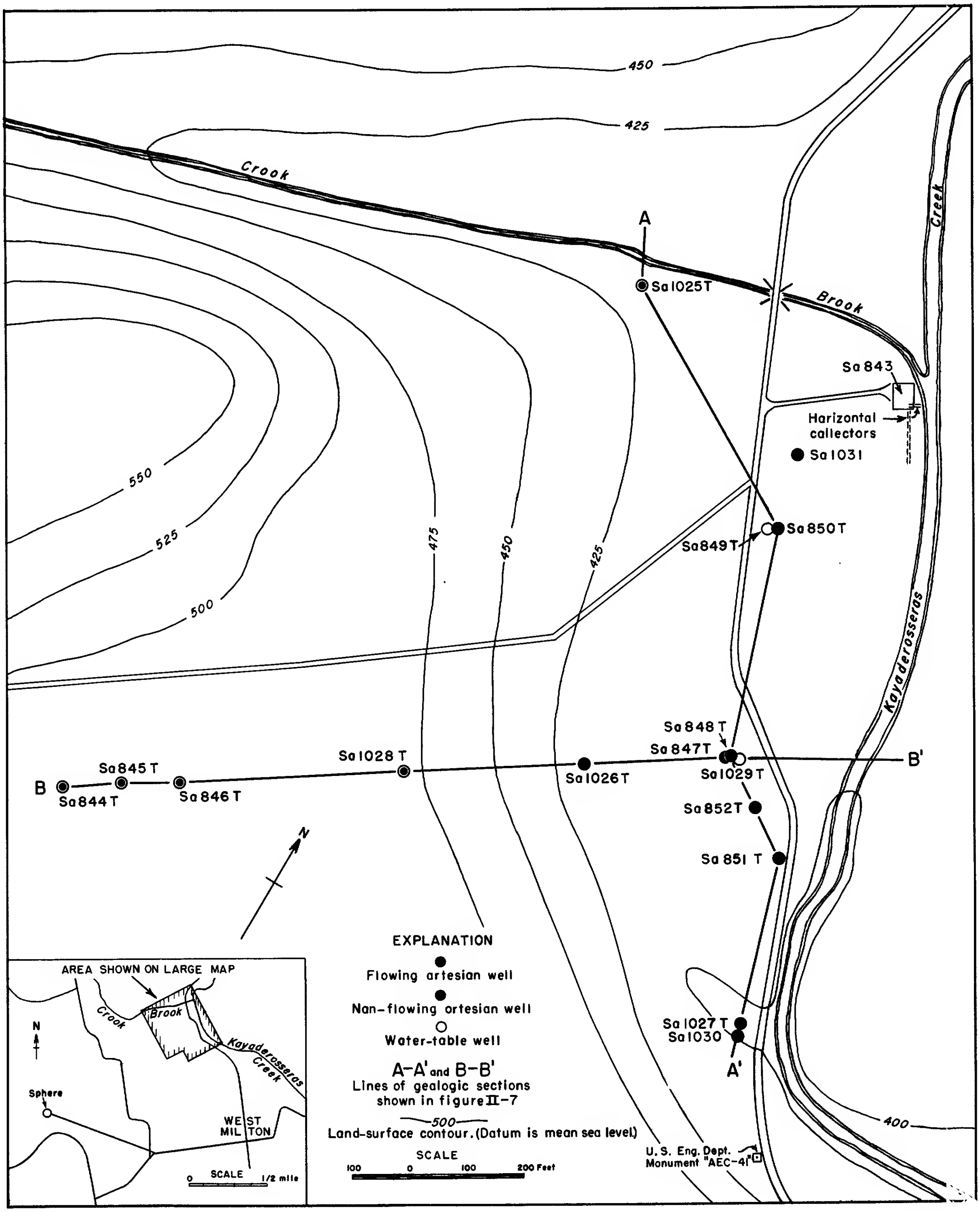

Figure II-9.--Map showing the location of the supply wells and test holes in the vicinity of Kayaderosseras Creek.

There are two distinct aquifers in the deposits underlying the valley of Kayaderosseras Creek. The vertical limits of these aquifers are shown in figure II-7. As may be seen from the figure, the upper 25 feet of the deposits constitutes a water-table aquifer in which the top of the zone of saturation, the water table, is free to rise and fall in response to changes in recharge and drainage. In wells Sa 847T and Sa 848T the deposits below a depth of about 50 feet comprise an artesian aquifer of unknown thickness. In this aquifer, the water is confined by the overlying relatively impermeable beds and the zone of saturation does not change in thickness. The development of water supplies from each of these aquifers by the Atomic Energy Commission is discussed in the following sections.

Water-table Aquifer

From 1951 to 1958, the entire water supply for the reactor site was obtained from well Sa 843, which is located about 25 feet from Kayaderosseras Creek and consists of a sump 5 feet wide, 8 feet long, and 25 feet deep and two horizontal laterals 36 inches in diameter. One lateral is 20 feet long and extends from the sump toward Kayaderosseras Creek. The other is 100 feet long and extends southward from the sump, parallel to Kayaderosseras Creek. The longer lateral consists of perforated corrugated metal pipe surrounded on the sides and bottom by 18 inches of coarse gravel and overlain by 6 feet of coarse gravel. It is not known whether the shorter lateral is also enclosed in a gravel envelope. After construction of the sump and laterals, a low mound was built around the sump to protect the pump house from the floods of Kayaderosseras Creek. Thus, the depth below land surface of the laterals ranges from about 19 feet at the sump to about 10 feet beyond the mound. The centerline of the laterals is about 5 feet below the bottom of Kayaderosseras Creek. Two pumps, one rated at 750 gpm and the other at 500 gpm, are installed on the well. The switching mechanism of the pumps is arranged so that only one can be operated at a time. Under normal operations, the smaller pump cuts on first and remains on until the use of water exceeds the yield of the pump. At this point, the switching mechanism cuts on the larger pump and cuts off the smaller pump.

The maximum yield of this well varies with the level of Kayaderosseras Creek. The specific capacity of the well is about 115 gpm per foot of drawdown. During periods of drought when the creek level would be at an altitude of about 400 feet (measured adjacent to the well), drawdown available in the well is about 6 feet and the yield is about 700 gpm. During periods of average, fair-weather flow creek level is at an altitude of about 401 feet and the yield of the well is about 800 gpm (Winslow, J. D., 1961, written communication). It is interesting to note that the static water level in well Sa 843 is lower than creek level as measured adjacent to the well whereas normally the static water level in the well would be expected to equal or to be higher than the level of the creek. This discrepancy is explained by the fact that the 100-foot long horizontal lateral extends downstream to a point where creek level is more than a foot lower than it is adjacent to the sump.

The water level in well Sa 843 is affected principally by pumping from the well and by changes in the stages of Kayaderosseras Creek and Crook Brook. The effect of pumping on the water level is shown by the hydrograph of well Sa 843 in figure II-10. Periods of pumping at rates of both 750 gpm and 500 gpm are shown. As may be seen from the graph, the well generally was

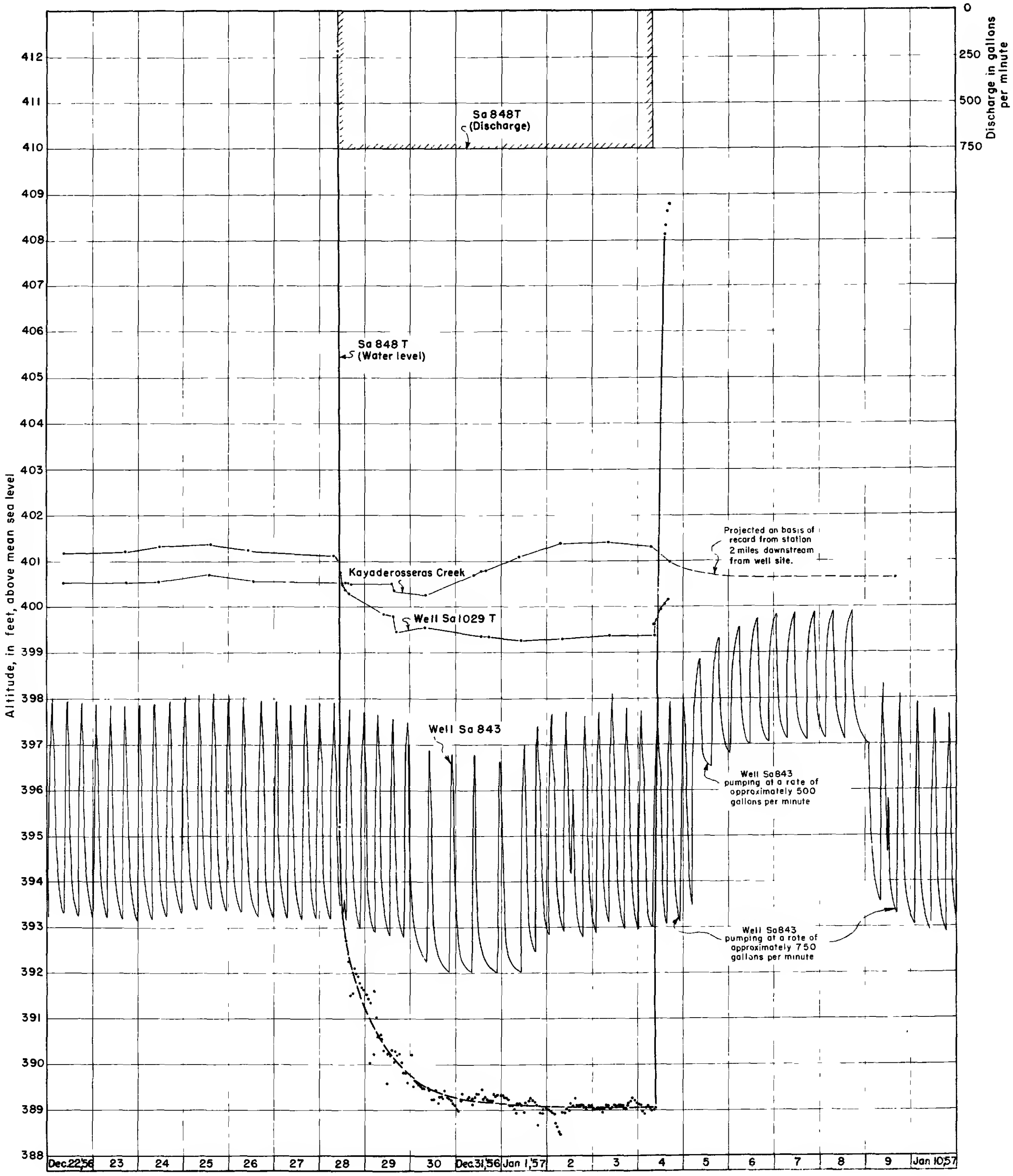

Figure 11-10.--Graphs showing the water level and discharge of well Sa 848T, water levels in wells Sa 843 and Sa 1029T, and the stage of Kayaderosseras Creek during the pumping test of December 1956-January 1957.

pumped continuously for a period of 6 hours and was idle for about 2 hours. A study of the records for the well collected during periods when there was a long interval between pumping cycles shows that the 750 gpm pump produces a drawdown of 7 to 9 feet. Between periods of pumping at a rate of 750 gpm, the water level in the well was able to recover only about $4\frac{1}{2}$ feet before the pump was turned on again. The 500 gpm pump, on the other hand, draws the water level in the well down 3 to 4 feet. Because the water level did not fully recover while the pump was off, the drawdowns produced by the pumping cannot be determined from well Sa 843.

The effect of pumping from well Sa 843 on the ground-water level in the adjacent flood-plain deposits is about 0.5 foot at well Sa 849T (location shown in figure 11-9) when well Sa 843 is pumped at a rate of 500 gpm. The water level in well Sa 849T responds almost immediately to the pumping. This indicates that the flood-plain deposits respond to short-period fluctuations as though the water in the aquifer was under artesian conditions. This condition probably stems, at least in part, from the fact that the deposits in the upper few feet of the aquifer are somewhat finer than the deposits in the middle and lower portions. The upper layer acts as a confining bed when the water level is lowered quickly but in all other respects the aquifer responds as a water-table aquifer.

The stage of Kayaderosseras Creek at well Sa 843 is shown in figure 11-10. It may be observed from the figure that the pumping level of well Sa 843 ranges from about 3 feet below creek level when the 500 gpm pump is operating to about 7 or 8 feet when the 750 gpm pump is operating. Under the normal pumping schedule, the water level in the well does not have sufficient time to rise to its static level during the brief periods when the pumps are off. Thus, during periods of pumping, a relatively steep gradient exists between the creek and the well, and water moves from the creek to the well. An indication of the extent to which Kayaderosseras Creek and, possibly Crook Brook, (fig. 11-9) contributes water to well Sa 843 is shown in figure 11-11 by the graphs of daily mean air temperature at the reactor site, minimum daily temperatures of the water in Kayaderosseras Creek 2 miles downstream from well Sa 843, and weekly measurements of the water temperature in well Sa 843 and Sa 849T. It may be seen from the figure that the temperature of the water in Kayaderosseras Creek ranges from 32°F to about 75°F and the temperature of the water from well Sa 843 ranges from 43°F to about 61°F. The temperature of well Sa 849T, which taps a part of the water-table aquifer that is not affected by Kayaderosseras Creek, ranged from 45.5°F to 48°F during the period shown in figure 11-11. The relatively wide range in the temperature of water from well Sa 843 indicates that the water from the well is a mixture of water from Kayaderosseras Creek, possibly Crook Brook, and the water-table aquifer. The proportion of the water derived from each source cannot be estimated from the data presently available.

Figure 11-11 also illustrates that the temperature of the water in Kayaderosseras Creek, as would be expected, closely coincides with the daily mean air temperature (with the exception, of course, for air temperatures below 32°F). The temperature of the ground water as measured in well Sa 849T averages a few degrees above the mean annual air temperature, which based on 60 years of record at Greenfield Center, about 7 miles northeast of the well site, is about 45.6°F.

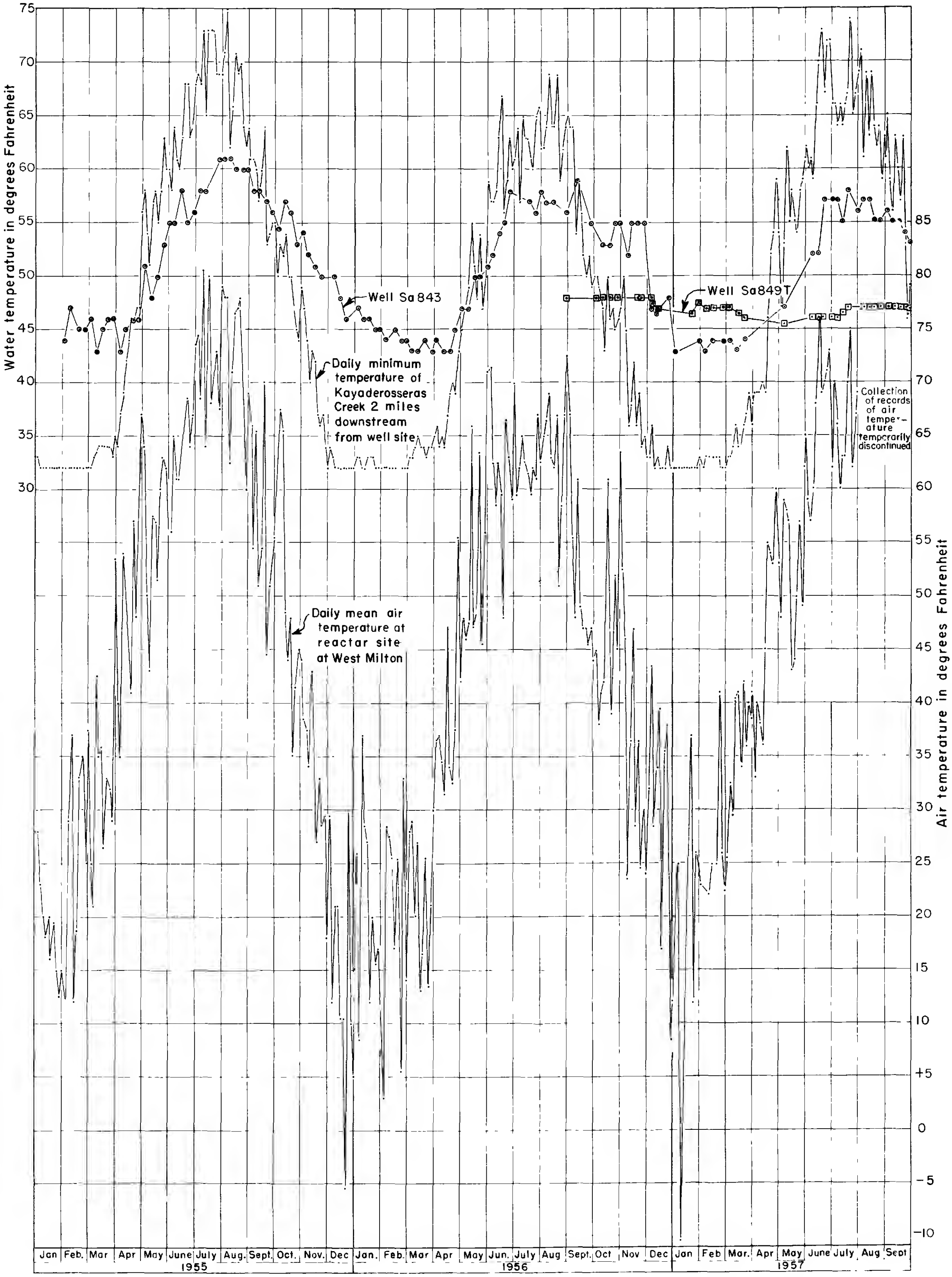

Figure 11-11.--Graphs showing the temperature of water in Kayaderosseras Creek and in wells Sa 843 and Sa 949T in the West Milton area, and air temperature at the reactor site.

Artesian Aquifer

The artesian aquifer underlying the valley of Kayaderosseras Creek consists of a medium to coarse sand interbedded with a few layers of gravel. (See figure II-7.) The top of this aquifer is about 50 feet below land surface. The two aquifers are separated by about 25 feet of silt containing some fine to coarse sand and clay. Because the artesian aquifer does not crop out at the surface, information concerning it has been obtained from samples collected during test drilling and from two pumping tests. Three supply wells now draw from this aquifer most of the water used by the reactor installation.

Data obtained during the construction of test wells Sa 848T-Sa 852T and Sa 1025T-Sa 1028T (fig. II-7 and II-9) show that this aquifer underlies a large part of the flood plain of Kayaderosseras Creek near the confluence of Crook Brook. The actual extent of the deposits comprising the aquifer cannot be determined from the data available. However, data obtained during the drilling of test wells Sa 844T and Sa 1028T indicate that the deposits become thinner west of the flood plain of Kayaderosseras Creek and apparently interfinger with lacustrine silts and clays. Data from test well Sa 1025T also indicate that the deposits thin or become finer toward the north. It should be noted, however, that this well was drilled near the western side of the flood plain and approximately 500 feet west of the creek. Well Sa 1030, which was drilled closer to the creek, penetrated a much thicker section of coarse-grained deposits. Nothing is known regarding the character and extent of the aquifer east of the creek. However, the analysis of data collected during the pumping test in April 1956 indicates that the coarse deltaic deposits may extend for a considerable distance east of the creek. The deposits appear to thin toward the south (fig. II-7) although they may extend for a considerable distance south of test well Sa 1027T.

As may be seen from the position of the piezometric surface in figure II-7, the artesian pressure at some locations is sufficient to raise the water to a height of at least 12 feet above the land surface. Two pumping tests, one in April 1956, and the other in December 1956-January 1957, were performed to determine the water-bearing characteristics of the aquifer. During the two tests, well Sa 848T was pumped and the effect of the pumping on the artesian and water-table aquifers was determined by measuring the depth to water in observation wells. Analysis of the data collected during these tests showed the transmissibility of the aquifer to be about 125,000 gpd/ft and the storage coefficient to be about 0.0003.[1/] (A discussion of methods used to analyze pumping-test data is included in the section on "Quantitative Studies" in Part III of this report.)

1/ An investigation of the yield of the West Milton well field was made in 1960, after the preparation of this report. The results of this later investigation place the maximum yield of wells Sa 848, Sa 1030, and Sa 1031, under drought conditions, at 925 gpm, 550 gpm, and 1,000 gpm, respectively, with drawdowns of 44 feet, 40 feet, and 47 feet, respectively (Winslow, J. D., 1961, written communication). In each case the pumping level in the wells would be at the top of the artesian aquifer.

During the second and most significant of the two pumping tests, well Sa 848T was pumped at a rate of 750 gpm for 7 days. Graphs of the water levels and other data collected during this pumping test are shown in figures II-10 and II-12. As may be seen from the figures, the water levels in all wells had stabilized by the end of the fifth day of pumping. The minor deviations of the water levels from a smooth curve can be attributed to the response of the aquifer to changes in barometric pressure. The water-level data shown in figure II-10 and II-12 have not been corrected for barometric pressure but a comparison of the changes in barometric pressure with the water-level records suggests that stabilized conditions may actually have been reached early in the fourth day. Prior to reaching stabilized conditions, a part of the pumpage was supplied by water released from storage in the aquifer. After stabilized conditions were reached, all of the pumpage was derived either from an increase in recharge to the aquifer or a decrease in natural discharge from the aquifer, or both.

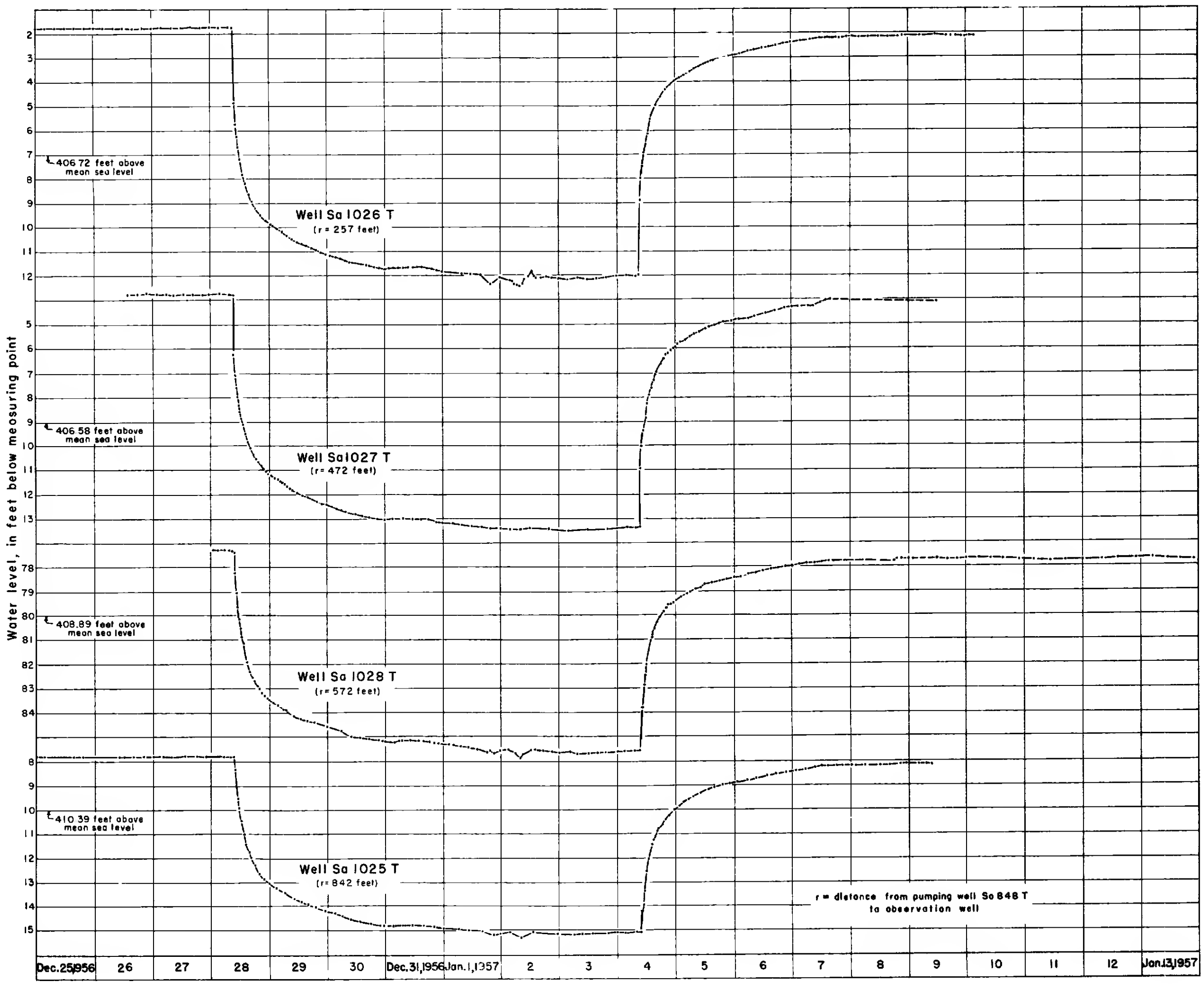

Figure II-12.--Graphs showing the decline of the water level in wells Sa 1025T-Sa 1028T during the pumping test of well Sa 848T, December 1956-January 1957.

In determining the effect pumping from the artesian aquifer has on water levels in the water-table aquifer, water-level measurements were made in well Sa 1029T, a well screened in the water-table aquifer and located 10 feet east of Sa 848T. Water levels in Sa 1029T showed an immediate response to pumping from well Sa 848T. (See figure II-10.) By the end of the fourth day the water level in well Sa 1029T had declined 1.8 feet. The water level in the well rose slightly after the fourth day, probably as a result of the rise in the stage of Kayaderosseras Creek. The cessation of pumping from well Sa 848T was accompanied by an immediate rise in the water level in well Sa 1029T. The hydrographs in figure II-10 show that the water level in well Sa 848T prior to the start of pumping was approximately 11 feet higher than the water level in well Sa 1029T. As a result of this difference in head, water was leaking upward from the artesian aquifer into the water-table aquifer prior to the start of pumping. During pumping, the water level in well Sa 848T declined to a position about 10 feet below the water level in well Sa 1029T. As a result, the movement of water upward from the artesian aquifer ceased in the vicinity of the pumping well and water, though certainly in negligible quantities, began moving downward from the water-table aquifer into the artesian aquifer.

WATER-LEVEL FLUCTUATIONS

In order to determine the extent to which water levels in the West Milton area fluctuate in response to changes in the rates of recharge and discharge and to other factors, records have been collected of the depth to water in selected wells. The records for wells Sa 838-Sa 841 for the period October 1954 to November 1955 are shown graphically in figure II-13. These are large-diameter dug wells penetrating unconsolidated deposits which contain water under water-table conditions. Wells Sa 838, Sa 839, and Sa 841 are in till and well Sa 840 is in the kame deposit north of the sphere. (See figure II-4 for the location of the wells.) Thus, the fluctuations of the water levels in these wells are probably indicative of the fluctuations of water levels in most of the area underlain by till and kames. The hydrographs in figure II-13 show that the relatively high precipitation in November 1954 together with the onset of cold weather, which decreased the rate of evaporation and stopped transpiration by plants, resulted in a rise in water levels. The water levels remained relatively unchanged through December but began to decline in January 1955. This decline correlated with the freezing of the ground which diminished recharge to the aquifer. As the ground began to thaw late in February, permitting water to percolate downward to the zone of saturation, the water levels began to rise. This rise generally continued until early May 1955 when resumption of plant growth and increase in the rate of evaporation started a new decline of the water levels. This decline continued throughout the summer of 1955 until rains in August and again in October produced marked rises in the water levels. Fluctuations of the water table in most of the West Milton area may be expected to follow the general pattern shown in figure II-13. However, departures from the pattern may occur from year to year owing to variations in precipitation and temperature.

Fluctuations of pressure in the artesian aquifer underlying Kayaderosseras Creek are shown in the hydrographs of wells Sa 848T, Sa 1026T, and Sa 1028T in figure II-14. (See figure II-9 for location of the wells.) As may be seen from figure II-14, the pattern of seasonal fluctuations in artesian pressures in this aquifer is similar to that of the water-table

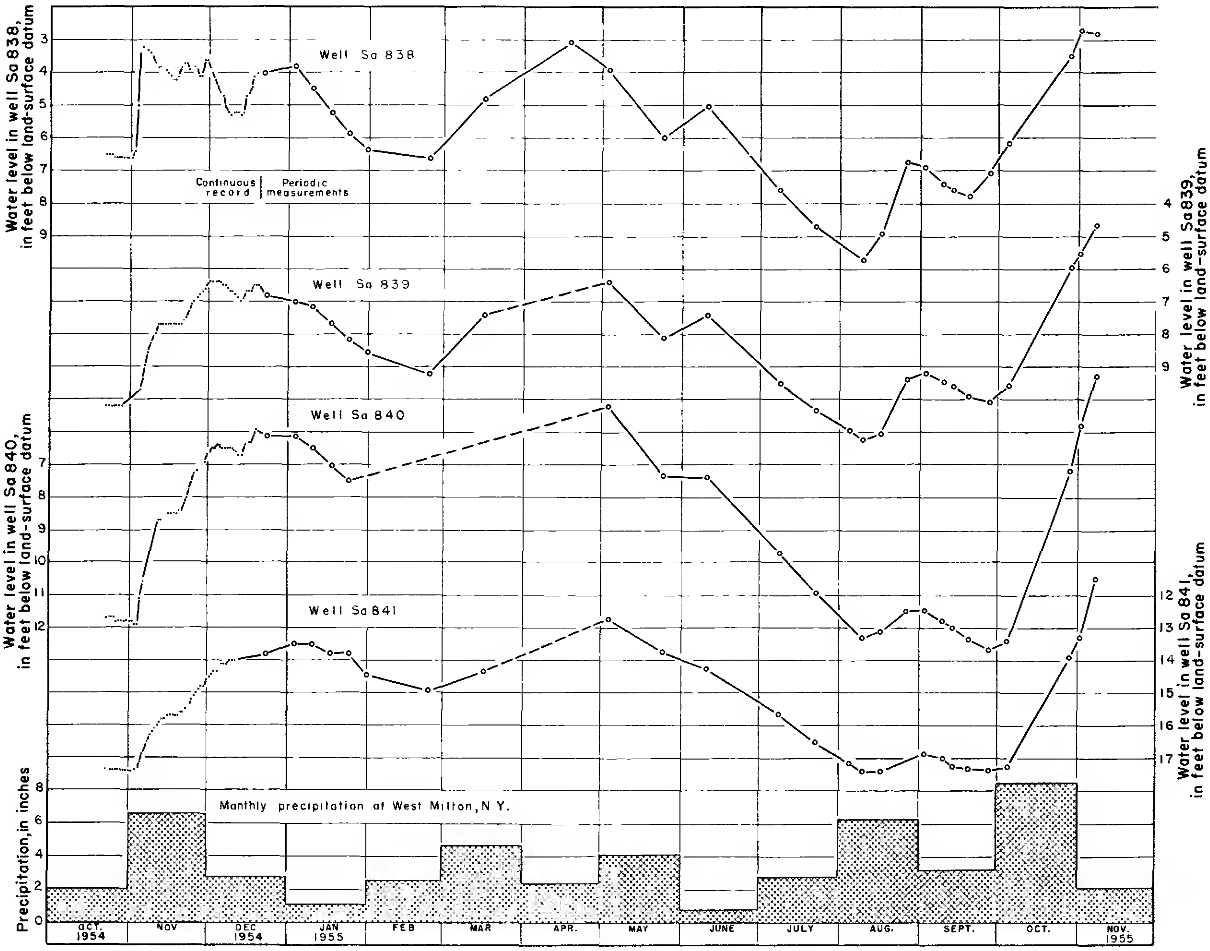

Figure 11-13.--Graphs showing the seasonal fluctuations of water levels in dug wells penetrating unconsolidated deposits in the West Milton area, and monthly precipitation at the reactor site.

aquifer as shown in figure 11-13. Continuous records from the recording gages installed on these wells also show daily fluctuations in artesian pressure due to changes in barometric pressure. Such fluctuations are generally less than 0.1 foot.

CHEMICAL QUALITY

Chemical analyses of 15 samples of water from 12 ground-water sources in the West Milton area are given in table 11-2.

Water from the artesian aquifer in the valley of Kayaderosseras Creek (see analyses for wells Sa 848T, Sa 1030, and Sa 1031 in table 11-2) is of the calcium magnesium bicarbonate type, has a hardness of about 100 ppm (parts per million) and has a dissolved solids content of about 120 ppm. (The locations of the wells in the valley of Kayaderosseras Creek are shown in figure 11-9.)

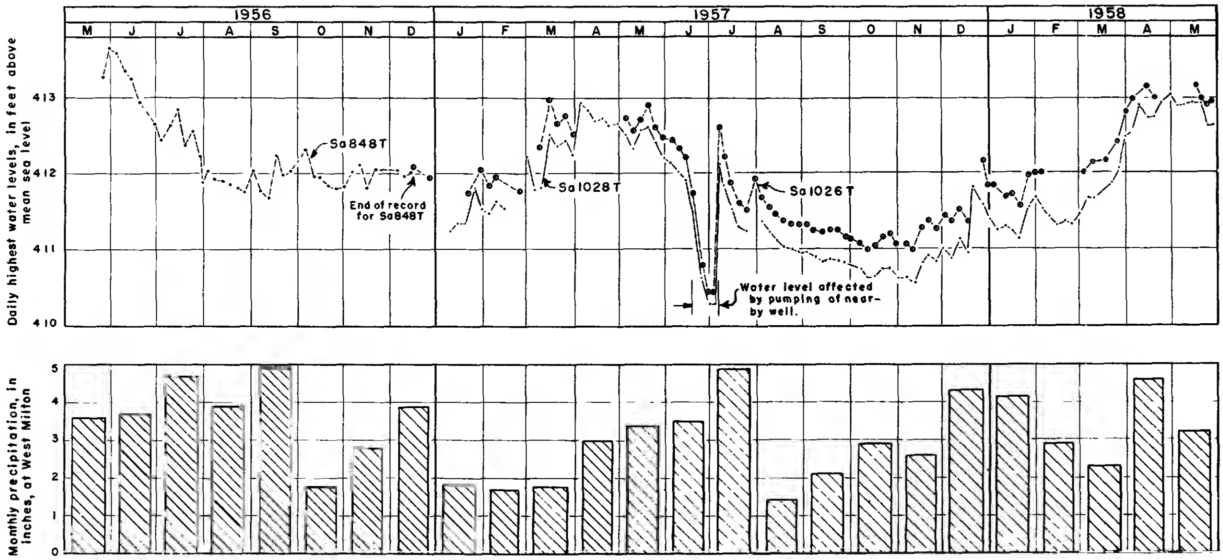

Figure II-14.--Graphs showing fluctuations of the water levels in wells penetrating the artesian aquifer in the vicinity of Kayaderosseras Creek and monthly precipitation at West Milton.

Water from the water-table aquifer in the valley of Kayaderosseras Creek is also a calcium magnesium bicarbonate water but it is a little more highly mineralized than water in the artesian aquifer underlying it. The hardness of water from wells Sa 843 and Sa 849T is 125 ppm and 115 ppm and the dissolved-solids content is 138 ppm and 127 ppm, respectively.

The two analyses of water from well Sa 528T (fig. II-4) show that water from the bedrock underlying the reactor installation has a hardness of 64 ppm. Both of these samples were collected while the well was being drilled, one when the well was 230 feet deep and the other when it was 675 feet deep. Dissolved solids increased from 214 to 268 ppm and bicarbonate increased from 256 to 366 ppm in the range of depths from 230 to 675 feet.

The other analyses listed in table II-2 are for water from wells tapping other unconsolidated deposits in the area. Water from well Sa 546, a shallow dug well tapping unconsolidated deposits 0.6 mile south of the hamlet of West Milton (fig. II-4), has a hardness of 224 ppm which is the highest hardness shown in the table. The concentration of iron did not exceed 0.3 ppm, the limit recommended by the U. S. Public Health Service (1961, p. 941, 943), except in water from two wells. These were well Sa 566 (0.97 ppm) which taps sand in the hamlet of West Milton, and well Sa 545 (0.31 ppm) which taps sand along Glowegee Creek 0.4 mile southeast of the sphere. The concentrations of fluoride (1.5 ppm), chloride (250 ppm), sulfate (250 ppm), and dissolved solids (500 ppm) were within the recommended limits for all wells.

Table 11-2.--Chemical analyses of ground water from the West Milton area

Source of analysis: A, Quality of Water Laboratory, U. S. Geological Survey, Albany, N. Y.; B, New York State Dept. of Health, Albany, N. Y.
(All results in parts per million except specific conductance, pH, and color)

Well or spring number	Location coordinates	Water-bearing material	Depth of well (feet)	Source of analysis	Date of collection	Water temperature (°F)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$: Calcium and magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Color
Sa 528T 1/	9X, 2.7N, 2.3E	Canajoharie Shale	230	B	1/10/49	--	--	0.40	--	--	--	--	--	234 2/	3.0	4.2	--	--	214	64	0	--	--	--
Sa 528T 1/	do.	Lowville Limestone-Canajoharie Shale sequence	675	B	3/ 1/49	--	--	.05	--	--	<0.01	--	--	305 3/	6.4	28	--	--	368	64	0	--	9.1	0
Sa 545	9X, 2.6N, 2.7E	Sand	7	A	5/ 1/51	--	10	.31	0.00	42	13	2.4	0.2	177	19	1.0	0.1	0.3	186	158	13	306	8.1	5
Sa 546	9X, 2.0N, 3.7E	Till (?)	12	A	9/24/52	--	9.9	.08	.43	76	8.4	11	8.4	245	29	14	.1	10	312	224	23	481	7.0	2
Sa 566	9X, 2.4N, 3.6E	Sand	17	A	9/24/52	50	7.1	.97	.01	33	11	2.1	.7	129	20	4.0	.0	2.1	149	128	22	244	7.7	7
Sa 603	9X, 2.5N, 6.3E	do.	14	A	9/24/52	--	11	.16	.04	36	9.0	5.4	.6	135	23	6.8	.0	.2	161	127	16	251	7.5	5
Sa 843 4/	9X, 3.5N, 3.3E	Sand and gravel	25	A	9/ 4/58	59	11	.10	.01	32	11	2.4	.7	136	11	3.2	.2	1.2	138	125	14	236	8.0	2
Sa 848T 5/	9X, 3.3N, 3.2E	Sand	99	A	4/13/56	49	11	.05	.01	22	11	5.8	.8	119	9.1	3.9	.1	.8	121	100	3	219	7.9	4
Sa 848T 6/	do.	do.	99	A	4/26/56	49	11	.02	.00	22	11	5.8	.6	121	10	3.2	.1	1.1	121	100	1	218	8.2	4
Sa 848T	do.	do.	99	A	9/ 4/58	51	10	.07	.01	23	9.9	5.8	.8	118	7.5	4.5	.3	2.9	115	98	2	210	7.6	1
Sa 849T	9X, 3.4N, 3.3E	Sand and gravel	26	A	8/30/56	47	14	.22	.00	28	11	4.1	.6	128	15	4.8	.0	.2	127	115	10	218	7.8	3
Sa 1030	9X, 3.2N, 3.2E	Sand	74	A	9/ 4/58	51	8.9	.17	.04	24	9.4	12	.7	134	3.5	5.0	.4	3.3	128	99	0	230	7.4	2
Sa 1031	9X, 3.3N, 3.3E	do.	105	A	9/ 4/58	51	11	.08	.22	23	9.4	4.1	.7	114	7.5	3.2	.2	1.6	113	96	3	202	7.8	1

1/ Sample was turbid when received in laboratory because it was taken during drilling of the well. Water was filtered before analysis.

2/ Water also contains 11 ppm CO_3.

3/ Water also contains 30 ppm CO_3.

4/ Sample probably a mixture of ground water and surface water.

5/ Collected 10 days before start of a pumping test.

6/ Collected 1 hour before end of 3-day pumping test.

PART III

GROUND-WATER RESOURCES OF SARATOGA NATIONAL HISTORICAL PARK AND VICINITY

By

Ralph C. Heath and Jordan A. Tannenbaum

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PART III

GROUND-WATER RESOURCES OF SARATOGA NATIONAL HISTORICAL PARK AND VICINITY

By

Ralph C. Heath and Jordan A. Tannenbaum

INTRODUCTION

In 1957 the U. S. National Park Service embarked on a 10-year program to improve and expand the facilities of the national parks to provide for the recreational needs of the Nation's growing population. This program, known as "Mission 66," involves not only the expansion of camping and other recreational facilities but also the reconstruction and care of historic structures and sites. As a part of this program, the National Park Service is constructing new roads in Saratoga National Historical Park which will make those points of interest connected with the Battles of Saratoga more readily accessible. In addition, a new headquarters and enlarged facilities for visitors are to be constructed on Fraser Hill in the northwestern corner of the park. It is anticipated that approximately 25 gpm of water will be needed for these facilities.

At the request of the National Park Service, the U. S. Geological Survey began an investigation of the ground-water resources of the area in May 1958. The field investigation consisted of:

1. The collection of data on the depth, diameter, yield, and other features of existing wells in the vicinity of the park.

2. A study of the source, yield, and other features of Dakota and Wilbur Springs.

3. An investigation of the thickness and extent of the surficial deposits underlying the northern part of the park.

4. Construction of test wells in the vicinity of Wilbur Spring.

5. Measuring the depth to water in observation wells at weekly intervals.

6. Measuring the flow from the two upper springheads on the Wilbur Spring ravine.

7. Conducting pumping test to determine the transmissibility and storage coefficient of the sand deposit in the vicinity of Wilbur Spring.

The field investigation of the thickness and extent of the surficial deposits included the boring of 23 holes with a power auger. This work was performed by Herbert T. Hopkins of the Hydrologic Laboratory, U. S. Geological Survey, Louisville, Ky. The test wells used in the pumping test were constructed by Hall and Company, Delmar, N. Y. Water samples collected as part of the investigation were analyzed by the Quality of Water Branch, U. S. Geological Survey, Albany, N. Y. Information on water wells was furnished by owners of property and local well drillers. Mr. Ivan Ellsworth, Superintendent, Saratoga National Historical Park, provided information on wells in the park and other data. The field work and preparation of this report were under the general supervision of George C. Taylor, Jr., former district geologist, U. S. Geological Survey.

GEOGRAPHY

Saratoga National Historical Park is located in the east-central part of Saratoga County about 10 miles southeast of the city of Saratoga Springs. (See figure I-2.) The park is an irregularly shaped area of about 4 square miles.

The park and vicinity encompass two topographically distinct areas. West of State Highway 32 (fig. III-1) the area consists of low hills elongated in a northeast-southwest direction, alternating with broad, relatively flat-bottomed valleys. The altitudes of the hills range from about 400 feet above sea level in the northwestern corner of the park to more than 600 feet above sea level a few miles west of the park. The floors of the valleys generally range in altitude from about 300 feet above sea level near State Highway 32 to 450 feet above sea level a few miles to the west.

East of State Highway 32 the area consists of two terraces and the flood plain of the Hudson River. The upper terrace ranges in altitude from about 260 feet to about 300 feet. It is generally less than half a mile wide and its surface is relatively irregular. Some of these irregularities are due to the presence of bedrock hills which were not covered by the sediments forming the terrace. However, many of the irregularities are doubtless due to stream erosion. The upper terrace is separated from the lower terrace by a gentle slope. The lower terrace ranges in altitude from about 230 feet to about 240 feet. The surface of the lower terrace slopes very gently toward the east. The steep-sided, v-shaped valleys that have been cut by streams crossing the lower terrace are one of the most striking topographic features in the area. The lower terrace is separated from the flood plain of the Hudson River by a steep, well-defined scarp more than 100 feet high. The flood plain is a nearly flat surface which ranges in width west of the river from about 0.1 mile near the Kroma Kill, to about 0.5 mile east of Mill Creek. The altitude of the flood plain ranges from 90 to 100 feet.

The major part of the area is drained by the Kroma Kill, Mill Creek, and their tributaries. These streams originate west of the park and flow east and south to the Hudson River.

The climate of the area is humid continental, characterized by long cold winters, short warm summers, and moderately heavy precipitation. Figure III-2 shows the normal monthly temperature at the U. S. Weather Bureau

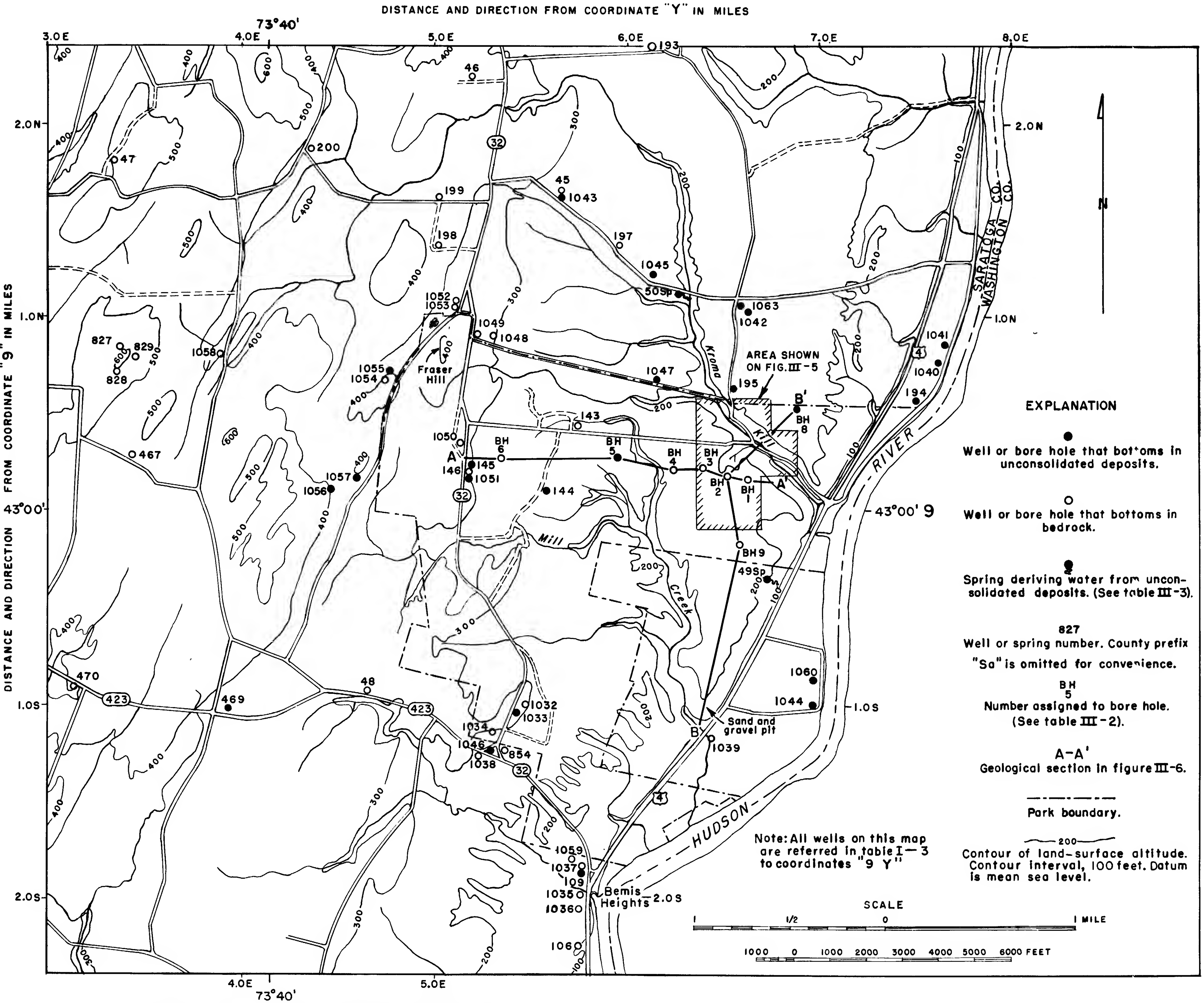

Figure III-1.--Map of Saratoga National Historical Park and vicinity showing location of selected wells, springs, bore holes, and geologic sections A-A' and B-B'.

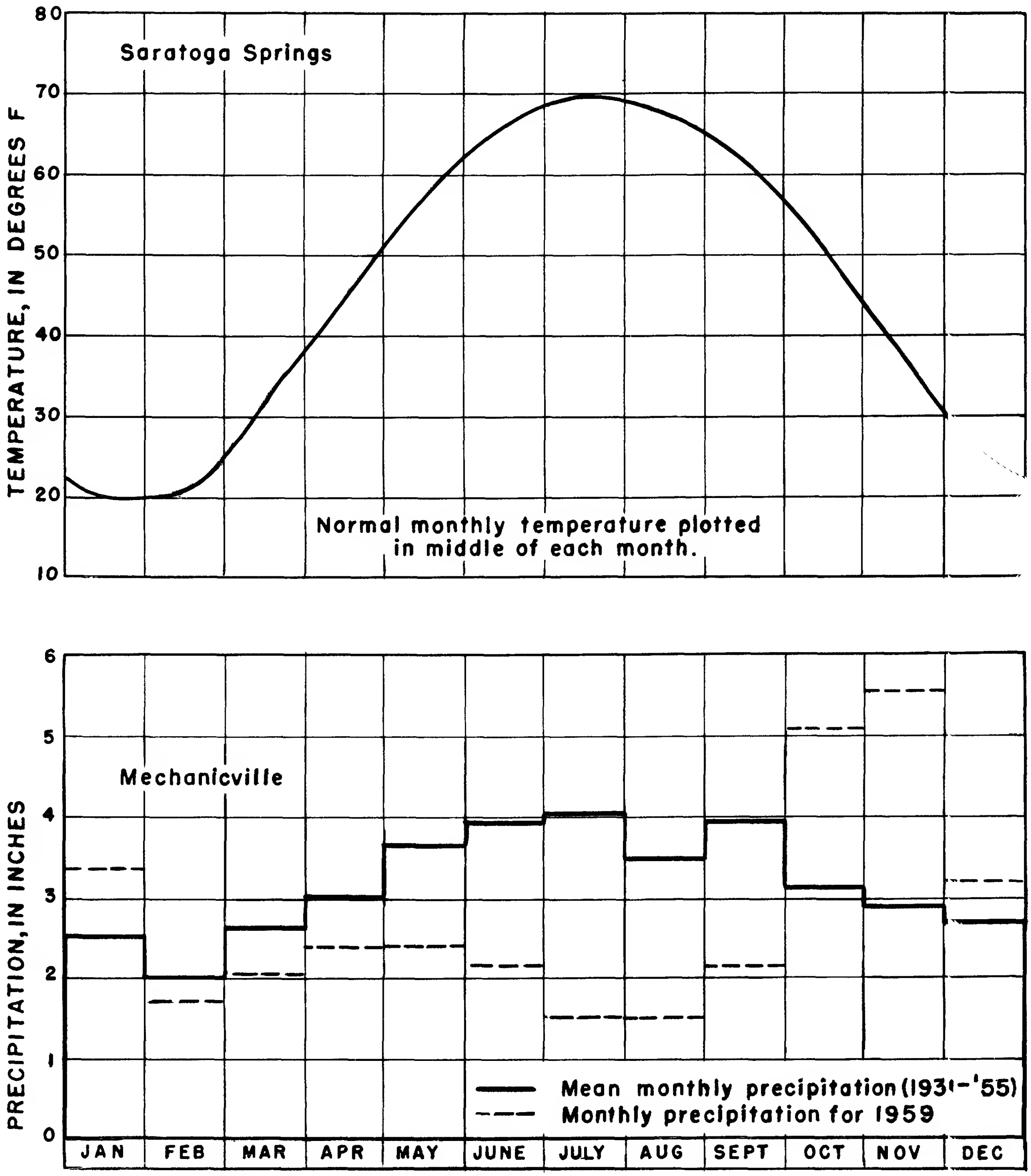

Figure III-2.--Normal monthly temperature at Saratoga Springs and monthly precipitation at Mechanicville.

substation 3.5 miles northwest of Saratoga Springs. The operation of this substation, which was located about 13 miles northwest of the park at an altitude of 550 feet above sea level, was discontinued in 1951. It may be seen from the figure that the normal monthly temperature ranges from a low of about 20°F in January to a high of about 70°F in July.

Figure III-2 shows also the mean monthly precipitation based on the records of the U. S. Weather Bureau from 1931 to 1955 at Mechanicville, which is located about 6 miles south of the park. As can be seen from the graph, precipitation is fairly evenly distributed throughout the year, although ordinarily it is slightly greater during the summer than in the other seasons. The mean annual precipitation at Mechanicville is 37.82 inches. Total annual precipitation at Mechanicville from 1911 to 1959 is shown in figure III-3. Temperature records are not collected at the Mechanicville station.

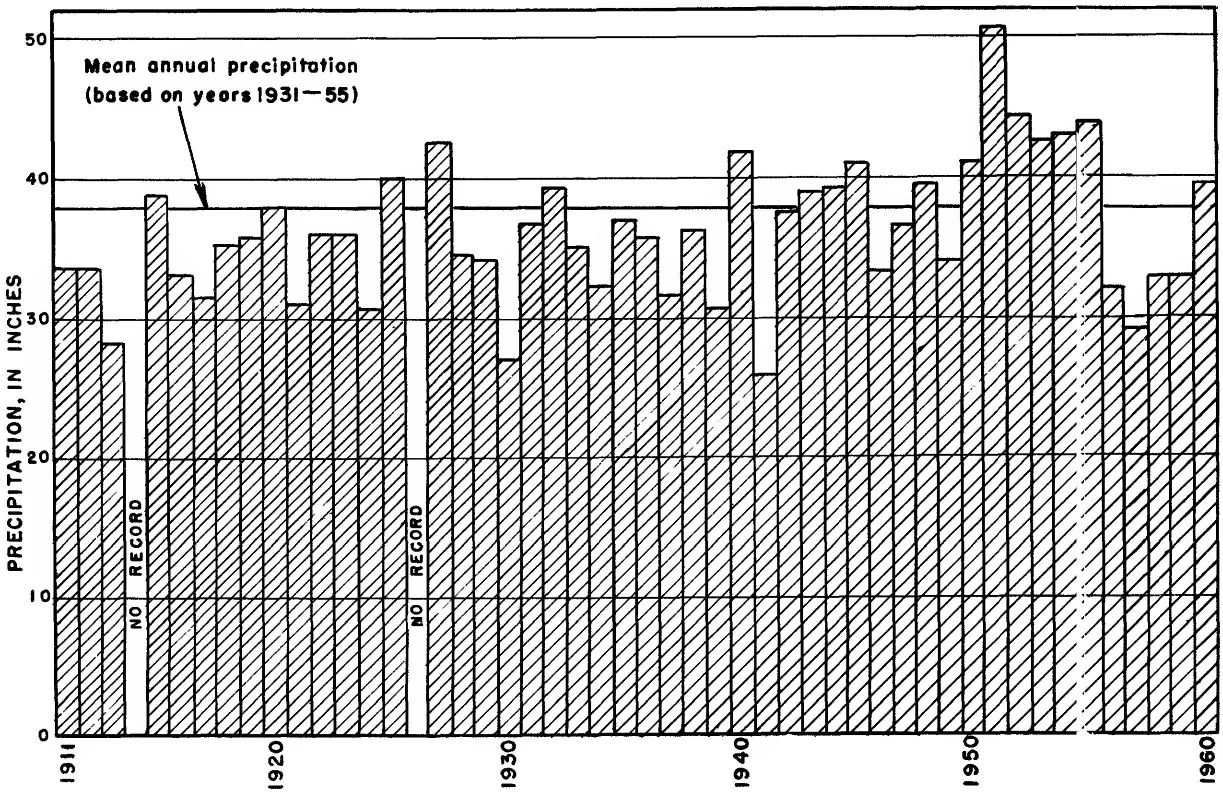

Figure III-3.--Total annual precipitation at Mechanicville.

The summer of 1959 was unusually dry. Precipitation at Mechanicville for July, August, and September 1959 was 5.08 inches or less than half of the 11.47 inches normally expected during those months. In comparison, the precipitation during July, August, and September 1958 was 10.31 inches.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES

From the standpoint of the occurrence of ground water, the rocks underlying the park are readily divisible into two distinct units. The first of these consists of unconsolidated deposits which extend from the surface to a maximum depth of more than 100 feet. The second unit consists of shale and sandstone, commonly referred to as bedrock, whose total thickness exceeds several thousand feet. Ground water in usable quantities may be obtained from either the unconsolidated deposits or from the bedrock.

Records of the depth, diameter, depth of casing, yield and other features of selected wells in the vicinity of the park are listed together with wells from other parts of the county in table I-3. Records of selected springs in the vicinity of the park are listed in table III-3. The locations of the wells and springs in the vicinity of the park are shown in figure III-1.

Bedrock

Bedrock underlies the entire area, although in most places it is covered by unconsolidated deposits to depths ranging from a few inches to more than 100 feet. Bedrock crops out in parts of the stream valleys and on some hills. As may be seen from section A-A' in figure III-6, the surface of the bedrock is irregular. The bedrock is Ordovician in age and has been differentiated by Ruedemann (Cushing and Ruedemann, 1914, p. 84 and 93, and Ruedemann 1930, p. 96 and 117) into the Normanskill Shale and the Snake Hill Formation. However, because there does not appear to be any appreciable difference in the water-bearing characteristics of these formations, they will be treated as a unit.

Character

The bedrock consists of blue-black to gray shale containing thin layers of gray to black sandstone. The shale layers generally range in thickness from a few inches to several feet. The sandstone layers, on the other hand, are rarely more than 2 to 3 inches in thickness. The sandstone layers contain considerable amounts of calcium carbonate, principally as a filling between the quartz grains. The bedrock has been tightly folded and broken by many faults and joints. In addition, the layers of shale are broken along numerous closely spaced parallel planes. In most parts of the area, these breaks are obviously along bedding planes.

Occurrence of Ground Water

Water occurs in the bedrock in openings along faults, joints, bedding planes, and cleavage planes. Although openings, particularly those developed along bedding and cleavage planes, appear to be relatively numerous in outcrops most of them are probably too small to transmit water readily. Furthermore, openings along joints, bedding planes, and cleavage planes tend to disappear or become tightly closed at depth. Thus, the yield of wells is generally not increased by drilling below a depth of about 300 feet unless the lower part of the well penetrates a more permeable formation or a zone in which the bedrock is crushed, as along some major faults.

The yield of wells drawing from bedrock depends on the number and size of the openings penetrated by the wells. In general, the yield of such wells is relatively low. Wells in Saratoga County drawing from the shale have an average yield of about 9 gpm (table I-2).

The average depth of the bedrock wells in the vicinity of the park is about 125 feet. The shallowest well, Sa 1048, is a dug well 7 feet deep. The deepest well, Sa 827, is a drilled well 526 feet deep which was originally drilled to a depth of 312 feet. It is reported that deepening the well did not increase the yield which initially was 12 gpm.

Chemical Quality of Water

Chemical analyses of water from selected wells and springs in the vicinity of the park are listed in table III-1, together with depth of well, water-bearing material, and date of collection. The analyses show that the chemical quality of water from the bedrock varies widely. The table contains several relatively comprehensive analyses of water from the three deep wells (Sa 827-Sa 829) at a U. S. Air Force installation about 1.5 miles west of the park. These analyses show a wide and striking variation from year to year in the amount of calcium, magnesium, sodium and potassium, and sulfate in the water. For example, these constituents in samples from well Sa 827 have ranged as follows: calcium, from 14 to 120 ppm; magnesium, from 2.5 to 26 ppm; sodium and potassium, from 35 to 140 ppm; and sulfate, from 31 to 211 ppm. Such wide variations in the chemical quality of water from wells have not been observed previously in upstate New York. In view of this, and in view of the fact that when the calcium is relatively high the sodium and potassium are relatively low, and vice versa, the sampling points were inspected to determine if some of the samples might have contained an admixture of water that had passed through a zeolite softener. As this inspection failed to reveal any possibility that the samples might have contained softened water from the installation's water system, the explanation for the variations must be sought elsewhere. Although the possibility that some of the variations may be manmade cannot be completely ruled out at this time -- for example, the relatively high chloride content in well Sa 828 in November 1953 may have resulted from salt used to deice streets -- it seems probably that most of the variations are due to natural causes.

The analyses for wells Sa 827 and Sa 829 appear to show the presence of two distinct types of water, one which can be termed a sodium bicarbonate water and the other a calcium magnesium bicarbonate water. Each sample is probably a mixture of these waters although their relative proportion in any sample varies considerable as shown by a comparison of the analyses for well Sa 827 for November 24, 1953, and November 22, 1955. These analyses, together with two analyses of samples from well Sa 828, well Sa 829, and spring Sa 51aSp, are shown graphically in figure III-4. The principal constituents of the samples collected in November 1953 from wells Sa 827 and Sa 828 and in July 1959 from well Sa 829 are sodium and bicarbonate whereas the principal constituents of the samples collected from well Sa 827 in November 1955 and from well Sa 828 in August 1957 are calcium and bicarbonate. In both these samples the sulfate content was also relatively high. The differences in the chemical composition from one time to the next indicate that the samples are from two distinct water-bearing zones. However, the position of these zones cannot be identified from the data presently available. Similarly, the geologic factors that cause the differences in chemical composition cannot be explained at this time. Of interest is the fact that the bicarbonate content shows only slight variation. This may indicate that water from both sources initially had about the same chemical composition and that, in view of the abundance of limestone and dolomite in the region, the water was calcium magnesium bicarbonate type. If this is correct, it may be reasoned that water from one of the sources came in contact with ion-exchange silicates and that calcium and magnesium ions were replaced by sodium ions by a process of ion-exchange. The possible presence of a zone of naturally softened water deserves further investigation.

Table III-1.--Chemical analyses of water from selected wells and springs in Saratoga National Historical Park and vicinity

Source of analysis: A, Quality of Water Laboratory, U. S. Geological Survey, Albany, N. Y.; B, New York State Dept. of Health, Albany, N. Y.
(All results in parts per million except specific conductance, pH, color, and turbidity)

Well or spring number	Depth of well (feet)	Water-bearing material	Source of analysis	Date of collection	Silica (SiO_2)	Total iron (Fe)	Total manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness (as $CaCO_3$) Calcium, magnesium	Hardness (as $CaCO_3$) Noncarbonate	Alkalinity (as $CaCO_3$)	Specific conductance (micromhos at 25°C)	pH	Color	Turbidity
Sa 143	80	Normanskill Shale	B	1941	--	0.6	--	--	--	--	--	--	4	--	0.09	--	380 2/	--	353	--	7.7	--	--
Sa 143	80	do.	B	7/20/53	--	1.8	--	--	--	--	--	--	2.4	0.4	.02	--	400 2/	--	378	--	7.9	--	10
Sa 144	10	Pleistocene till	B	1941	--	.2	--	--	--	--	--	--	2	--	.7	--	110 2/	--	76	--	7.0	--	--
Sa 145	17	do.	B	1941	--	.2	--	--	--	--	--	--	5.2	--	.02	--	150 2/	--	217	--	7.5	--	--
Sa 146	80	Normanskill Shale	B	1941	--	.2	--	--	--	--	--	--	5.6	--	6.0	--	100 2/	--	88	--	7.2	--	--
Sa 146	80	do.	B	7/20/53	--	.5	--	--	--	--	--	--	36	.3	.02	--	240 2/	--	220	--	7.5	15	5
Sa 827	312	do.	A	6/13/51	9.4	--	--	14	2.6	120	283 3/	36	4.8	.4	.4	353	46	0	260	610	8.8	10	--
Sa 827	312	do.	A	3/12/52	10	.02	--	34	8.1	83	306	34	7.6	.5	.5	332	118	--	251	538	7.8	3	--
Sa 827	312	do.	A	3/17/53	13	.07	--	68	11	37	286	51	7.0	.1	1.0	324	214	0	234	528	7.5	2	--
Sa 827	312	do.	A	11/24/53	9.6	.23	--	13	2.5	122	320	31	8.2	.5	.4	351	43	0	262	555	8.3	10	--
Sa 827	312	do.	A	11/22/55	12	.22	12	120	26	35	332	211	4.7	.1	5.3	612	426 2/	154	272	889	7.8	2	1.3
Sa 827	312	do.	A	6/ 5/56	11	.06	.00	28	14	60	230	59	4.2	.0	2.7	292	128 2/	0	189	487	8.0	2	--
Sa 827	312	do.	A	10/17/56	11	.18	.07	30	5.7	140	338	110	7.0	.2	.7	462	98	0	277	745	8.2	2	.3
Sa 827	526	do.	A	8/27/57	10	.05	.13	24	4.9	125	326	70	6.2	.2	2.6	412	80	0	267	670	7.5	5	.4
Sa 827	526	do.	A	7/30/58	10	.01	.09	22	4.8	125	288	71	17	.2	15	413	75	0	236	647	7.7	2	.0
Sa 828	322	do.	A	6/13/51	13	.76	--	56	14	19	245	32	2.8	.2	.2	276	197	0	201	487	7.6	10	--
Sa 828	322	do.	A	3/12/52	13	.05	--	24	7.9	86	292	32	4.1	.3	.3	314	92	--	240	516	8.2	3	--
Sa 828	322	do.	A	3/17/53	13	.05	--	52	10	56	270	54	11	.1	.7	324	171	0	221	529	7.7	0	--
Sa 828	322	do.	A	11/24/53	13	.38	--	32	14	171	339	96	88	2.4	1.1	587	137	0	278	967	8.0	9	--
Sa 828	322	do.	A	11/22/55	12	.09	.09	60	12	75	288	90	21	.1	2.1	406	199	0	236	675	7.9	5	2.2

Table III-1.--Chemical analyses of water from selected wells and springs in Saratoga National Historical Park and vicinity (Continued)

Well or spring number	Depth of well (feet)	Water-bearing material	Source of analysis	Date of collection	Silica (SiO_2)	Total iron (Fe)	Total manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness (as $CaCO_3$) Calcium, magnesium	Hardness (as $CaCO_3$) Noncarbonate	Alkalinity (as $CaCO_3$)	Specific conductance (micromhos at 25°C)	pH	Color	Turbidity
Sa 828	322	Normanskill Shale	A	6/ 5/56	10	0.15	0.10	44	8.4	94	289	100	4.0	0.0	2.3	403	144	0	237	650	7.5	2	0.4
Sa 828	322	do.	A	10/17/56	11	1.2	.45	78	26	71	310	178	10	.2	1.4	541	302	47	254	814	7.5	2	[illegible]
Sa 828	322	do.	A	8/27/57	11	1.2	1.9	94	24	28	242	176	8.1	.1	1.3	486	333	135	198	777	7.5	4	.3
Sa 828	322	do.	A	7/30/58	8.5	4.7	1.8	63	18	115	280	221	13	.2	2.5	574	231	2	230	867	7.1	2	.0
Sa 828	322	do.	A	7/23/59	7.4	3.4	.58	62	16	104	256	210	12	.2	.5	541	221	11	210	839	6.5	2	1.0
Sa 829	468	do.	A	6/13/51	9	.02	--	33	8.1	63	219	64	4.2	.2	.6	288	116	0	180	512	7.9	10	--
Sa 829	468	do.	A	3/17/53	9.7	.03	--	59	6.9	51	233	66	18	.2	1.6	321	175	0	191	526	7.7	2	--
Sa 829	468	do.	A	11/24/53	11	.43	--	25	8.0	116	308	38	39	.6	.2	392	96 2/	0	252	648	7.8	8	--
Sa 829	468	do.	A	11/22/55	12	.05	.07	34	8.6	76	244	43	27	.3	1.9	336	120 2/	0	200	556	7.9	2	--
Sa 829	468	do.	A	10/17/56	10	.04	.00	21	4.9	121	305	59	16	.3	.3	369	73	0	250	617	7.9	3	.4
Sa 829	468	do.	A	8/27/57	10	.01	.09	28	3.9	124	316	63	21	.5	.0	403	86	0	259	668	7.9	4	.4
Sa 829	468	do.	A	7/30/58	10	.05	.03	36	6.0	108	296	68	24	.3	.0	400	115	0	243	650	7.3	3	1.0
Sa 829	468	do.	A	7/23/59	9.9	.03	.02	38	5.3	106	302	64	22	.6	.5	396	117	0	248	648	7.1	2	[illegible]
Sa 1032	294	do.	B	7/20/53	--	.15	--	--	--	--	304 4/	--	2.0	.8	.09	--	34	--	281	--	8.3	0	--
Sa 1077	24	Pleistocene sand	A	8/13/59	--	.03	--	--	--	--	48	--	2.0	--	--	--	56 2/	0	39	113	7.5	--	--
Sa 48Sp 6/	--	do.	B	5/18/49	--	.15	--	--	--	--	--	10	.8	--	1.1	--	96	--	89	--	7.5	0	--
Sa 48Sp 6/	--	do.	A	7/22/58	--	.02 7/	--	--	--	--	--	--	--	--	--	--	114 5/	--	--	232	7.5	--	--
Sa 48aSp	--	do.	A	7/22/58	--	.01 7/	--	--	--	--	--	--	--	--	--	--	85 5/	--	--	170	7.7	--	--
Sa 51Sp 8/	--	do.	A	7/22/58	--	.02 7/	--	--	--	--	--	--	--	--	--	--	66 5/	--	--	137	7.7	--	--
Sa 51aSp	--	do.	A	7/2[illegible]/58	10	.02	.00	25	3.8	.7	77	12	.9	.1	.9	95	79	14	65	156	7.9	2	--

1/ Includes both dissolved and suspended solids.

2/ Total hardness.

3/ Water also contains 17 ppm CO_3.

4/ Water also contains 19 ppm CO_3.

5/ By compleximetric titration.

6/ Collected at culvert on north side of graded road.

7/ Includes only dissolved iron.

8/ Collected 800 feet downstream from Sa 51aSp.

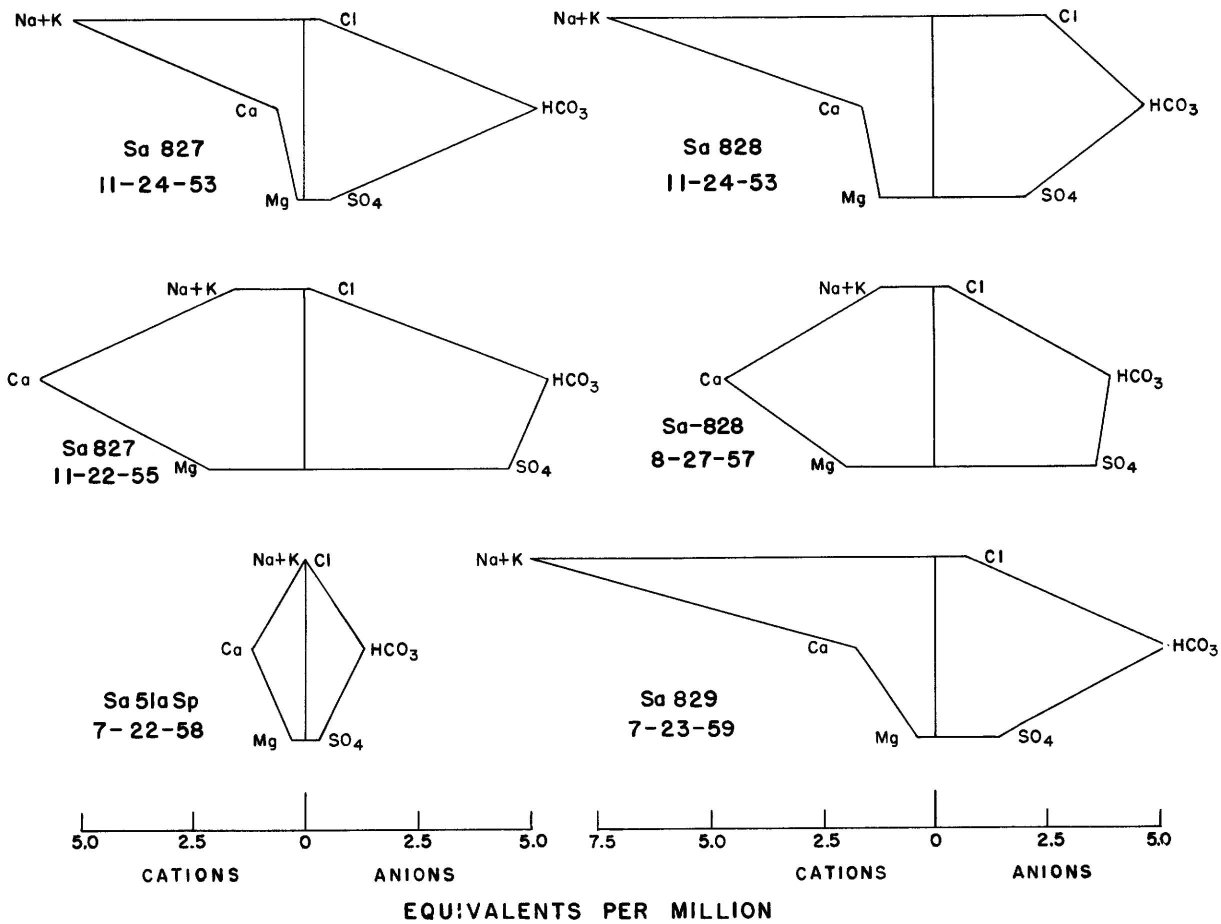

Figure III-4.--Graphs showing the principal constituents of selected chemical analyses of water from wells Sa 827-Sa 829 and spring Sa 51aSp.

The hardness of the water from wells Sa 827-Sa 829 shows the same wide variations as does the calcium and magnesium content. The hardness of water from well Sa 827 ranged from 43 to 426 ppm (table III-1). Prior to use, some of the water from the wells is passed through a zeolite softener.

The pumps in wells Sa 827-Sa 829 have to be removed periodically to permit removal of chemical precipitates from the screens at the bottom of the pump columns. Although the precipitate has not been analyzed, it is presumed to be composed principally of calcium carbonate formed from the breakdown of calcium bicarbonate following the release of carbon dioxide which accompanies the reduction in pressure during pumping. This reduction in pressure amounts to more than 300 feet of water.

Hydrogen sulfide gas, which smells like rotten eggs, is one of the most recognizable constituents of the water from bedrock wells in the vicinity of the park. A concentration of hydrogen sulfide as low as 0.5 ppm can be detected both by taste and odor. Waters having a concentration above 1 ppm are considered objectionable for most uses. Hydrogen sulfide is readily detectable by taste in 10 of the 30 bedrock wells shown

in figure III-1. Determinations made by the U. S. Geological Survey, show that water from well Sa 1059 contains 2.5 ppm and water from well Sa 1032 contains 20 ppm of sulfide expressed as hydrogen sulfide. Although it is not possible to determine which sulfides are present in the water, hydrogen sulfide probably is the principal one.

Unconsolidated Deposits

The bedrock in the park and vicinity is overlain by a layer of unconsolidated deposits ranging in thickness from a few inches near bedrock outcrops to more than 100 feet beneath the flood plain of the Hudson River and the low terrace immediately west of the flood plain. All these deposits were formed during the Pleistocene Epoch (popularly called the "ice age"), except for a thin layer, probably less than 20 feet thick, which has been deposited on the flood plain in Recent time by the Hudson River. The unconsolidated deposits in the vicinity of the park consist of several distinct units. From oldest to youngest these are, till, sand and gravel, clay, sand, and alluvium.

Figure I-3 (in Part I) is a map showing the unconsolidated deposits in Saratoga County. Records of selected wells deriving water from the unconsolidated deposits are listed in table I-3, and the locations of the wells are shown in figure III-1.

The northwestern corner of the park and small areas in the western part of the park are underlain by till which was deposited by an ice sheet that advanced across the area in Pleistocene time. In one place the till is overlain by a deposit of sand and gravel. The sand and gravel and, where it is absent, the till, are overlain by clay which was deposited in the quiet waters of a lake that occupied the area after the retreat of the ice sheet. This lake was called Lake Albany by Woodworth (1905, p. 175) who believed that it once occupied much of the area from the vicinity of Rhinebeck in Dutchess County to the vicinity of Schuylerville. Figure I-3 shows that much of the area in Saratoga County along the Hudson River is underlain by the silt and clay which was laid down in this lake. In the vicinity of the park this fine-grained material is predominantly clay and extends westward from the Hudson River to about the 300-foot contour line which is shown in figure III-1.

On the terrace bordering the flood plain of the Hudson River the clay is covered by a thin deposit of fine to medium sand. This sand is the uppermost deposit of the Pleistocene Epoch and was probably formed during the final stages of Lake Albany.

The youngest materials in the area are the alluvium which the Hudson River has deposited on its flood plain during times of flood. The alluvium consists of both fine- and coarse-grained sediments.

A test-boring program was conducted in August 1958 to determine the physical character and extent of the different unconsolidated deposits in the park. This program was limited to the northern part of the park because the studies to that time indicated that the surficial sand deposit underlying the northeastern corner of the park was the best source of water readily available to the new facilities to be constructed on Frazer Hill.

The locations of the test holes are shown in figures III-1 and III-5. Geologic sections based on data obtained from the test-boring program are shown in figure III-6. The records of holes bored with the power auger are given in table III-2. The following discussion of the different deposits is based on the detailed work in the northern part of the park but the description of the deposits and their water-bearing characteristics is applicable to these deposits elsewhere in the vicinity of the park and in the other parts of the county where they occur.

Till

Description.--Till is the oldest unconsolidated deposit in the area. Where present it directly overlies bedrock. Above an altitude of about 300 feet, which includes most of the western part of the area and several isolated hills in the southwestern part of the park, the unconsolidated deposits are composed entirely of till. Figure III-6 shows that only bore hole BH 3 (along line A-A') may have penetrated till. Only a small amount of the material penetrated in the lower 7 feet of this hole was brought to the surface by the power auger. Although this material appeared to be a mixture of clay, silt, sand, and pebbles representative of till, it could not be positively identified as till and may have been disintegrated bedrock. None of the other holes which reached bedrock penetrated till. Thus, it appears that till below an altitude of about 300 feet occurs as discontinuous masses, if present at all. The materials comprising the till were derived largely from the shales underlying the area. Thus, till contains a relatively large percentage of clay-size and silt-size particles. Where the till was compacted by the weight of the ice it is dense and hard to drill through and is called "hardpan" by drillers. The till ranges in thickness from zero at bedrock outcrops to more than 50 feet at places in the western part of the area. Generally, it appears to be less than 25 feet thick.

Occurrence of ground water.--The poor sorting and the high clay content of the till result in both a low porosity and a low permeability. Thus, water in usable quantities can be obtained from till only from large-diameter wells which have a large area for the infiltration of water and a large volume for the storage of water between periods of pumping. The most common diameter of dug wells is about 3 feet but one dug well near the park, well Sa 1056, is reportedly 16 feet in diameter. The sustained yield of wells drawing from till is seldom known because pumps are operated for short periods and draw mostly from storage in the well. However, based on experience elsewhere, the yield of most wells drawing from till is probably only a few hundred gallons a day. In those wells which are dug only a few feet below the water table, the water level is apt to fall below the drop pipes of pumps during exceptionally dry seasons.

Water-level fluctuations from April 1958 to November 1959 in well Sa 145, a dug well in till, are shown in figure III-8. During the period of observation the water level fluctuated through a range of 4.5 feet. The rather abrupt rises in the water level in October and November 1958, and at other times, suggests that surface runoff may enter the well, possibly through a permeable zone alongside the curbing. For a discussion of the seasonal fluctuations of the water table see "Occurrence of ground water" in the section on "Sand".

Table III-2.--Records of holes bored by power auger in the northern part of Saratoga National Historical Park

Bore hole no.	Well no.	Log				Altitude (feet above mean sea level)				Depth to water table below land surface (feet) 2/	Thickness of saturated sand (feet) 2/
		Material penetrated	From (feet)	To (feet)	Thickness penetrated	Measuring point 1/	Land surface	Top of clay	Water table 2/		
BH 1		Sand Clay Bedrock	0 9 72	9 72 73	9 63 1		222	213	214	8	1
BH 2		Sand Clay Bedrock	0 17? 90	17? 90 91	17? 73? 1		219	202?	210	9	8?
BH 3		Sand Clay Till or bedrock	0 3 21	3 21 28	3 18 7		236	233	--	--	0
BH 4		Sand Clay Bedrock	0 3 91	3 91 92	3 88 1		235	232	--	--	0
BH 5		Sand Clay	0 5	5 106	5 101		244	239	--	--	0
BH 6		Silty soil Clay Bedrock	0 3 41	3 41 48	3 38 7		272	269	--	--	0
BH 7		Sand Clay	0 10	10 37	10 27		222	212	--	--	0
BH 8		Sand Clay	0 21	21 53	21 32		--	--	--	15	6
BH 9		Sand Clay Bedrock	0 18? 75	18? 75 76	18? 57? 1		225	207?	217	8	10?
BH 10		Sand Clay	0 14	14 18	14 4		217	203	208	9	5
BH 11		Sand Clay	0 7	7 33	7 26		224	217	217	7	0
BH 12		Sand Clay	0 18	18 28	18 10		229	211	215	14	4
BH 13	Sa 1065	Sand Clay	0 18	18 28	18 10	224.0	222	204	211	11	7
BH 14	Sa 1066	Sand Clay	0 11	11 23	11 12	218.8	215	204	210	5	6
BH 15		Sand Clay	0 9	9 26	9 17		220	211	212	8	1
BH 16		Sand Clay	0 9	9 11	9 2		222	213	214	8	1
BH 17		Sand Clay	0 8	8 13	8 5		219	211	212	7	1
BH 18	Sa 1067	Sand Clay	0 26	26 33	26 7	227.2	225	199	215	10	16
BH 19	Sa 1068	Sand Clay	0 21	21 28	21 7	229.5	226	205	217	9	12
BH 20		Sand Clay	0 12	12 18	12 6		231	219	222	9	3
BH 21		Sand Clay	0 16	16 18	16 2		230	214	--	--	?
BH 22	Sa 1069	Sand Clay	0 24	24 33	24 9	228.3	225	201	218	7	17
BH 23		Sand Clay	0 15	15 25	15 10		225	210	218	7	8

1/ Measuring point is top of 1½-inch pipe.

2/ Water-table data and thicknesses of saturated sand for wells Sa 1065-Sa 1069 were determined from water-level measurements made on Aug. 14, 1958. All other water-table data and thicknesses of saturated sand were determined from observations made during construction of the test holes during the period Aug. 4-9, 1958.

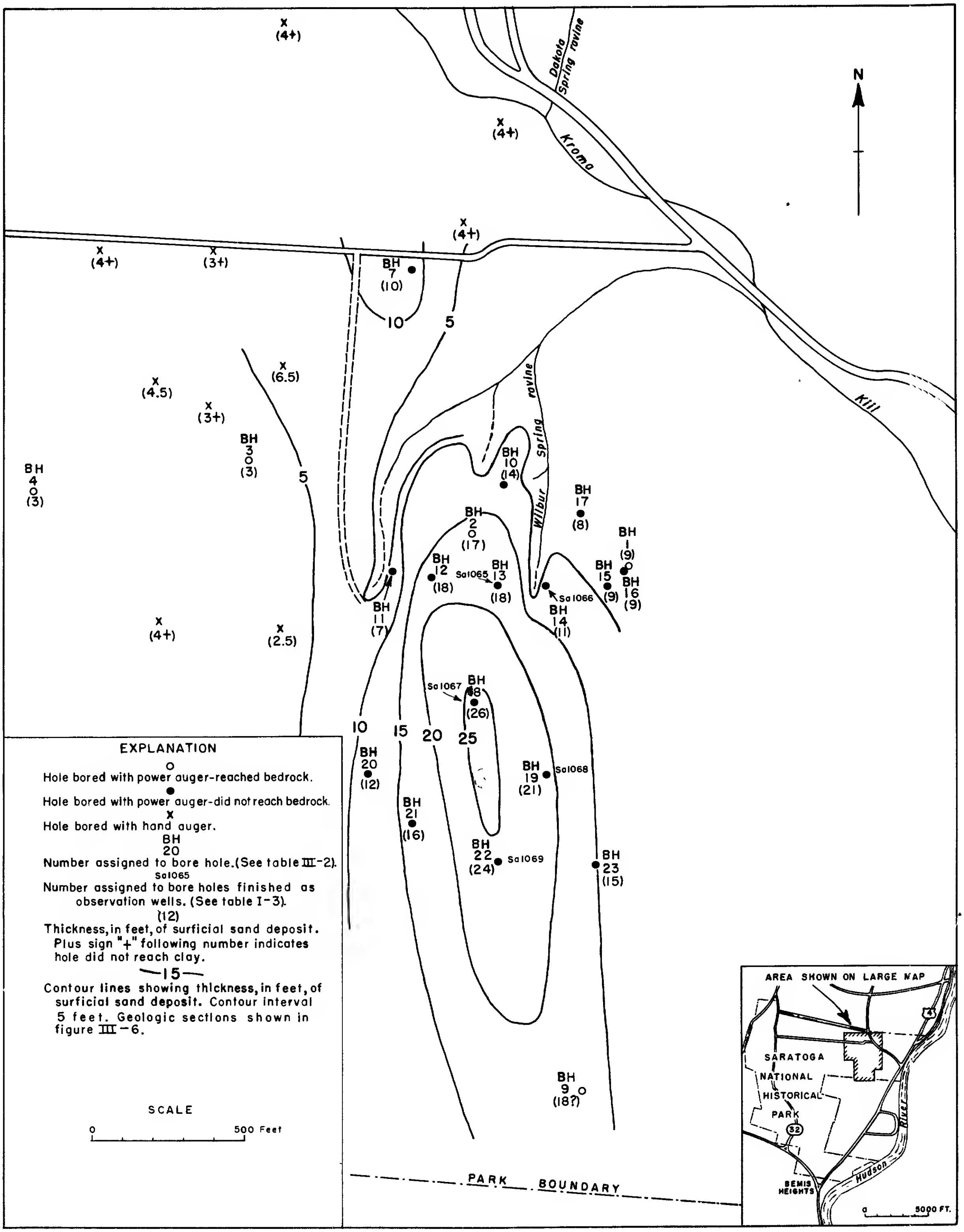

Figure III-5.--Map showing position of bore holes and observation wells, and thickness of the surficial sand deposit in the vicinity of Wilbur Spring ravine.

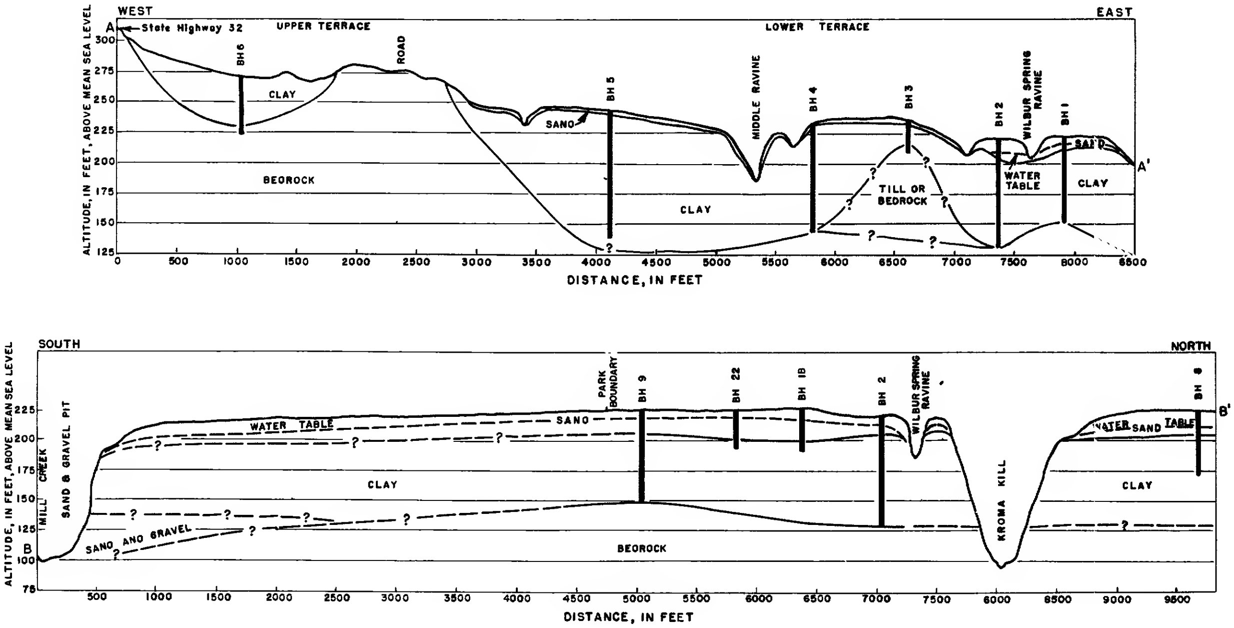

Figure III-6.--Geologic sections in Saratoga National Historical Park along lines A-A' and B-B' in figure III-1.

Sand and Gravel

Description.--The lowermost stratified deposit known to exist in the area consists of sand and gravel which is exposed in a pit a few hundred feet north of the point at which U. S. Highway 4 crosses Mill Creek. (See figure III-1.) This is the only known occurrence of the deposit in the area. The southernmost bore hole (BH 9), located about 1,700 feet south of the Wilbur Spring ravine did not penetrate this deposit (section B-B', fig. III-6). Thus, it appears that the sand and gravel extends only a short distance north of the pit. It is not known whether the deposit is present in the area south of Mill Creek. The bottom of the sand and gravel is not exposed and, therefore, its thickness is not known.

The section exposed in the pit is listed below. It should be noted that the top of the pit is about 25 feet below the surface of the lower terrace. It is assumed (section B-B', fig. III-6) that the 25 feet of material removed at the top of the pit was composed of sand. The four feet of sand at the top is believed to have slumped or been bulldozed from further up the slope.

Description	Thickness	Depth below top of pit
Sand, fine, orange	4	0- 4
Clay, thin-bedded, brown to gray	47	4-51
Sand and gravel. Sand is fine to medium and crossbedded. Gravel occurs in lenses	36+	51-87+

Occurrence of ground water.--No wells are known to draw from the sand and gravel deposit. The overlying clay no doubt greatly retards the downward movement of water into the deposit. Moreover, because of the relatively high permeability of the deposit and its dissection by streams any water percolating into it through the overlying clay can drain readily into Mill Creek or into the Hudson River valley. Thus, it appears that this deposit cannot be considered a potential source of substantial water supplies in the park. However, if present in other parts of the area it might serve as a source of supply if more favorably situated with respect to recharge and discharge.

Clay

Description.--In the northern part of the park, and presumably throughout most of the eastern part of the area shown in figure III-1, the lowermost stratified deposit consists of clay which was deposited in Lake Albany, the lake that existed in the area after the melting of the last ice sheet. As may be seen from section A-A' in figure III-6, bore hole BH 5 penetrated 101 feet of this clay. Although this hole did not reach the bedrock it is believed that bedrock was only a short distance below the bottom of the hole. The clay appears to be the only unconsolidated deposit in the area occupied by the upper terrace. On the lower terrace, it is covered by a veneer of fine to medium sand.

Occurrence of ground water.--Although the clay deposit is not a potential source of water in the area it has considerable influence on the occurrence of water. As pointed out in the preceding section, it doubtless impedes the downward percolation of water. Thus, in that part of the upper terrace in which the clay forms the surficial deposit most of the precipitation either runs off to streams or stands on the surface until dissipated by evaporation or the transpiration of plants. On the lower terrace the clay serves as an impermeable bottom to the sand deposit that blankets the terrace. The effect of the clay layer on the occurrence of ground water in the sand deposit will be discussed in greater detail in the following section.

Sand

Description.--The surface of the lower terrace is underlain by a veneer of well-sorted fine to medium sand. The sand is made up almost entirely of angular grains of quartz. In addition, it contains a small percentage of rounded shale particles and angular fragments of mica and dark-colored silicate minerals. Although no detailed studies have been made of the origin of the deposit, it appears to have been laid down when the waters of Lake Albany were receding.

The veneer of sand ranges in thickness from 1 to 2 feet near the western margin of the lower terrace to more than 25 feet in the vicinity of bore hole BH 18 (fig. III-6). It may also be noted from the figure that the thickest section of the sand seems to coincide with a slight depression in the surface of the clay. The thickness of the sand deposit in the vicinity of the Wilbur Spring ravine is shown with contour lines in figure III-5. It may be observed from the figure that the thickest part of the deposit is a north-south elongated lens-shaped mass lying to the west and

south of the ravine. This mass ranges in thickness from 10 to 20 feet. The deposit appears to decrease in thickness in all directions, the decreases to the east and west being the most abrupt. The extent of the deposit in the area immediately north of bore hole BH 7 is not known because it was impossible to enter the area with the power auger. However, it is doubtful that more than about 10 feet of the sand remains between bore hole BH 7 and the Kroma Kill. In the northeastern corner of the park, bore hole BH 8 (figs. III-1 and III-6) penetrated about 21 feet of sand before entering clay. The profile of the Dakota Spring ravine (fig. III-11) shows a thickness of about 20 feet of sand.

In order to determine the particle-size distribution of the sand, sieve analyses were made of samples from selected bore holes. The results of these analyses are shown in figure III-7. As may be seen from the figure, the deposit is composed largely of fine to medium sand. The steepness of the curves indicates that the deposit is well sorted. A comparison of the graphs in figure III-7 with the position of the bore holes in figure III-5 indicates that the sand immediately above the clay in bore holes BH 12 and BH 20, west and southwest of the Wilbur Spring ravine, is coarser than that from bore holes BH 14 and BH 19, east and south of the ravine.

Wherever vertical sections of the sand deposit are exposed in the area the surface is slumped to such an extent that details of the stratification are no longer apparent. However, fresh exposures of surficial sands in the vicinity of the city of Albany that are known to have been deposited in Lake Albany show horizontal stratification. The individual strata are generally a small fraction of an inch to about an inch thick and consist of alternating layers of silty fine sand and medium to coarse sand. It is assumed that the surficial sand deposit in the vicinity of the park is similarly stratified. This assumption is indirectly substantiated by the pumping-test data discussed in a following section. As the sand samples for which sieve analyses were made (fig. III-7) were obtained from an auger it is likely that each sample represents a mixture of several of the finer-grained and several of the coarser-grained layers.

Occurrence of ground water.--The surficial sand deposit appears to be the only important aquifer in the unconsolidated deposits in the area. Water occurs in this deposit under water-table conditions. The sole source of recharge to the aquifer is precipitation. However, only a part of the precipitation reaches the water table. Most of the precipitation that falls during the growing season is returned to the atmosphere by evaporation and by the transpiration of plants. Part of the precipitation falling during the winter is returned to the atmosphere by evaporation or by sublimation from snow and ice, and a part runs off over the surface during periods when the ground is frozen. The water that reaches the water-table moves under the influence of gravity to areas of discharge such as streams, springs, and seeps along valley sides.

Changes in the rates of recharge to and discharge from the sand deposit are reflected by the water-level measurements made in wells Sa 1065-Sa 1069 (bore holes BH 13, BH 14, BH 18, BH 19, and BH 22). The water levels in these wells are shown graphically in figure III-8 together with monthly precipitation at Mechanicville. As can be seen from the graphs, the water level in well Sa 1069 fluctuated through a range of about 3 feet from August

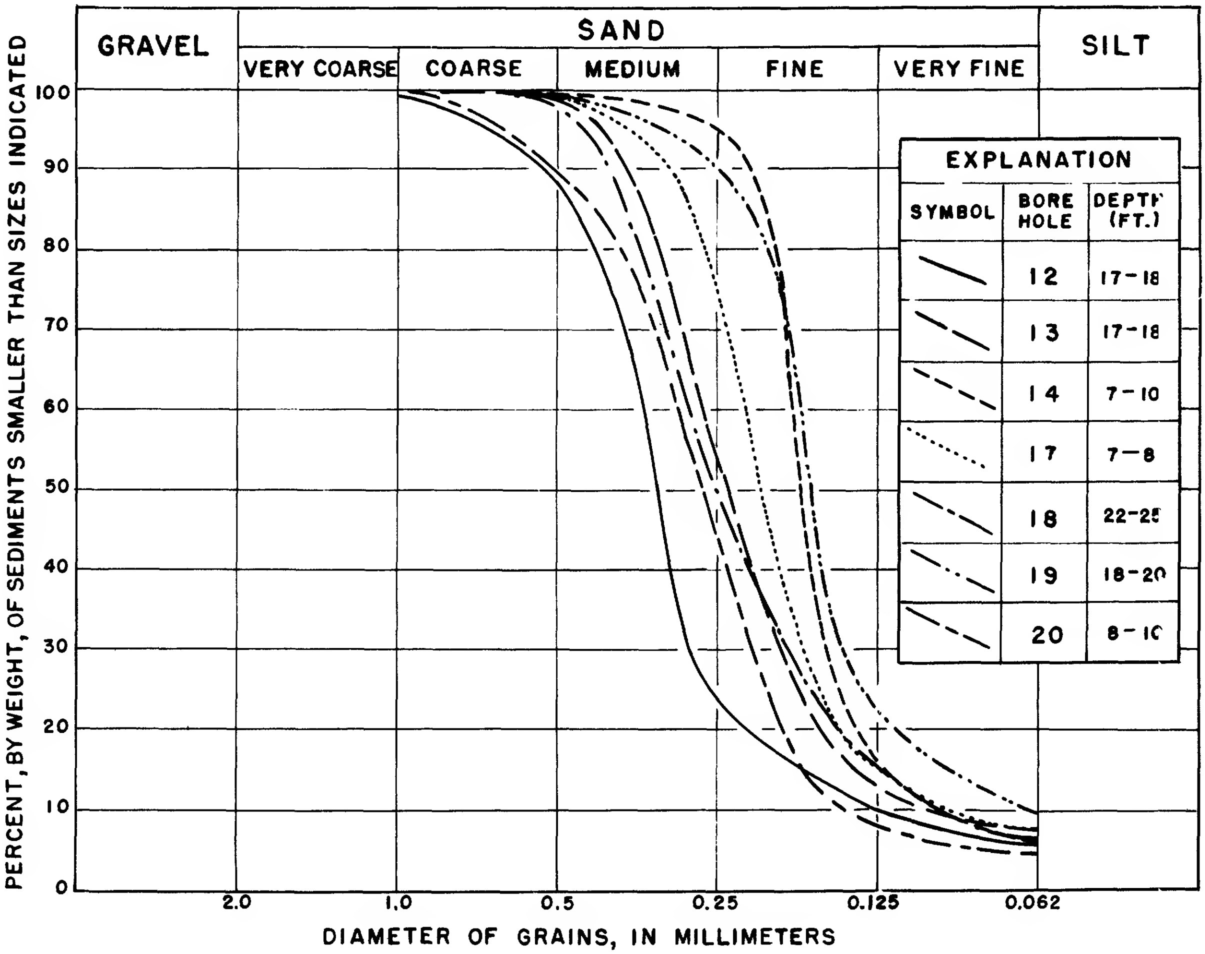

Figure III-7.--Graphs of particle-size analyses of sand samples collected immediately above the sand-clay contact from selected bore holes in the vicinity of Wilbur Spring ravine. (The lines representing the diameter of the particles are spaced according to the logarithms of these diameters.)

1958 to December 1959. The water level in Sa 1065, closest well to the main point of discharge, springhead Sa 51aSp on the Wilbur Spring ravine, fluctuated only about 1 foot during the same period. The graphs also show that recharge to the aquifer, as reflected by an upturn in water levels, occurred intermittently from November 1958 to March 1959. Between March and May considerable recharge occurred, part of which was derived from melting snow and part from precipitation.

That many factors, in addition to precipitation, affect the water levels in wells is even more clearly illustrated in figure III-9. This figure shows the daily highest water level in well Sa 1072 obtained from an automatic recording gage, the daily maximum and minimum temperature at Saratoga Springs, daily precipitation at Mechanicville, and the water equivalent of snow on the ground at the Albany Airport. It may be seen that precipitation from August to the middle of November had little, if any,

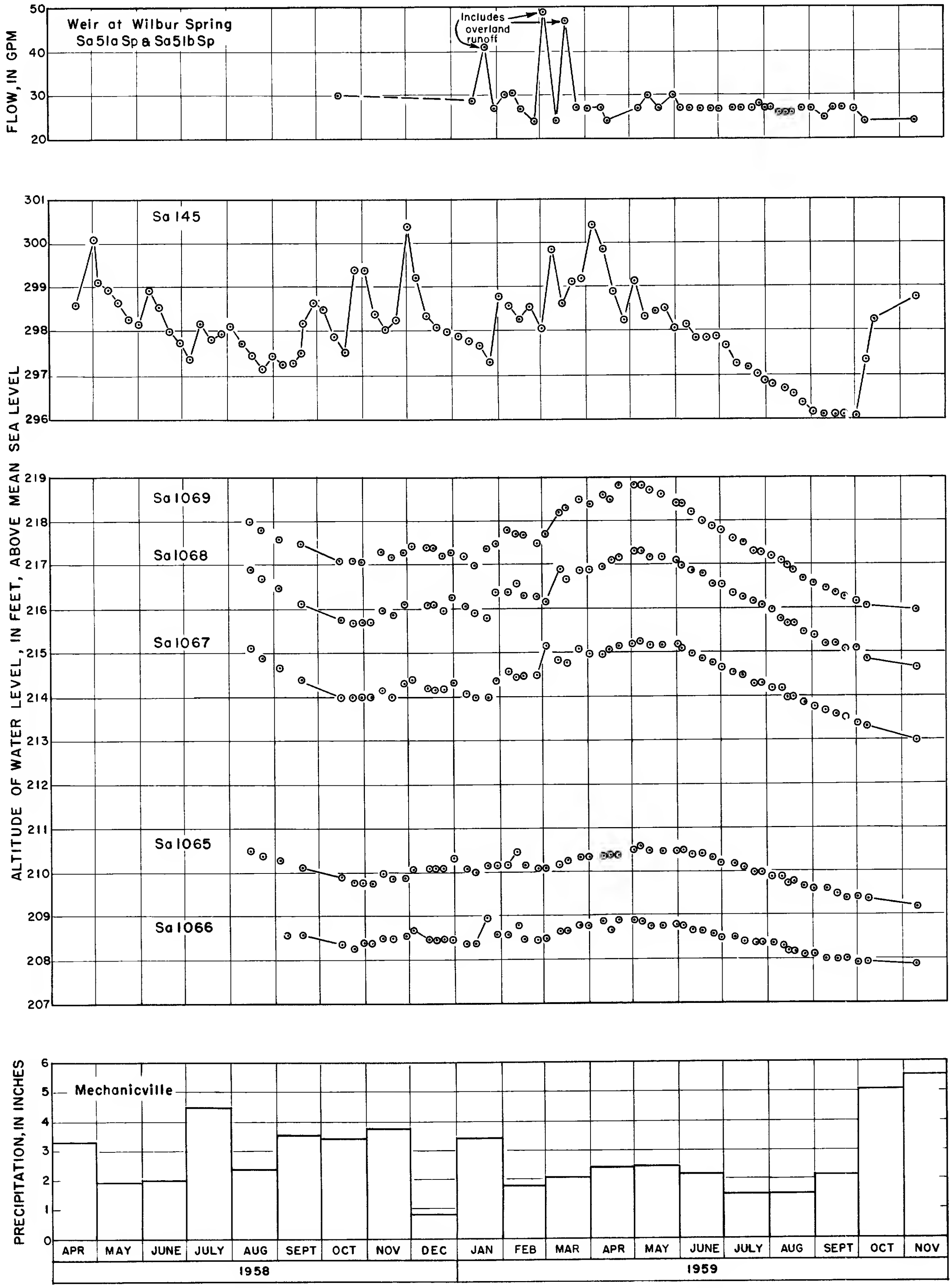

Figure III-8.--Graphs of the flow from the springs at the head of Wilbur Spring ravine, water levels in observation wells, and monthly precipitation at Mechanicville.

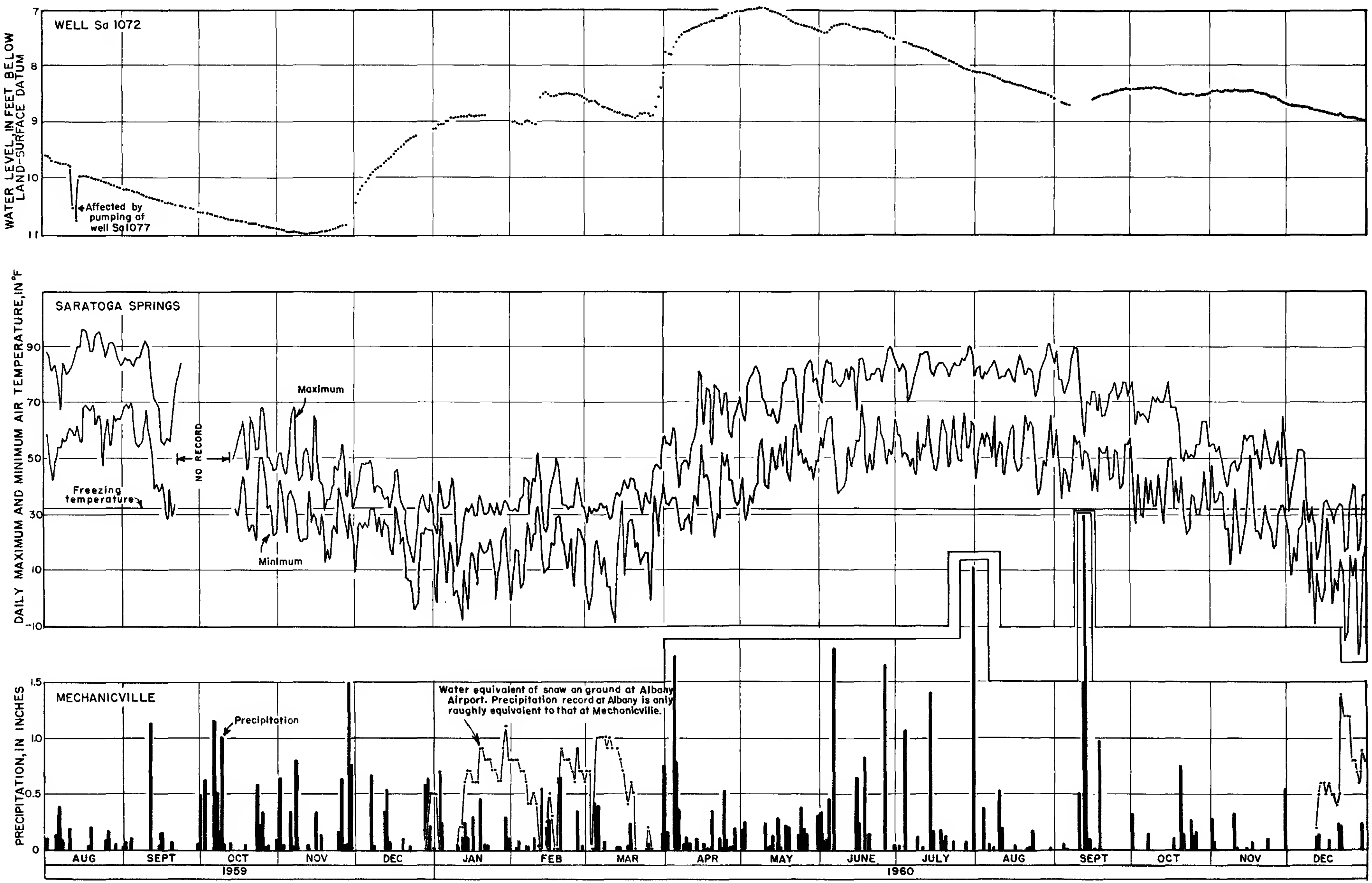

Figure III-9.--Graphs of the daily highest water levels in well Sa 1072, daily maximum and minimum air temperature at Saratoga Springs, daily precipitation at Mechanicville, and water equivalent of snow on ground at Albany airport.

effect on water levels. Freezing temperatures first occurred at Saratoga Springs in mid-September. However, because the northeastern corner of the park is about 125 feet lower than the weather station at Saratoga and is affected also to some extent by the warming effect of the Hudson River, it appears likely that temperatures at the park were not low enough in mid-September to stop plant growth. A review of temperature records at the Albany Airport during the period of missing record at Saratoga Springs (from September 24 to October 13) suggest that the first killing frost did not occur at the park until about October 19. Thus, during the period from August to mid-October the precipitation was utilized in plant growth or was evaporated. Precipitation after plant growth stopped in October and until the water level in well Sa 1072 started to rise in mid-November was either utilized in replenishing soil moisture or was evaporated. Precipitation from mid-November to mid-January caused substantial rises in the water table. Some of the precipitation during this period was in the form of snow which, however, did not remain on the ground long because temperatures during the day were generally above freezing. Except for the thaw in mid-February, recharge was negligible from mid-January until the onset of warmer temperatures in late March. Heavy rains in late March and early April provided substantial recharge to the sand deposit.

A map of the water table in the vicinity of the Wilbur Spring ravine, based on measurements made during the test-boring program in August 1959, is shown in figure III-10. The water table, which represents the top of the zone of saturation, ranges in altitude from less than 210 feet adjacent to the Wilbur Spring ravine to more than 220 feet in the vicinity of bore hole BH 20. The thickness of the zone of saturation in the surficial sand deposit in the vicinity of the Wilbur Spring ravine, as determined from measurements made in August 1958, is also shown in figure III-10. The area of the thickest sections of saturated sand coincides with the area where the sand deposit itself is thickest in the vicinity of well Sa 1067. (See figures III-5 and III-6.)

Figure III-10 indicates that most of the water in the deposit in the area contoured on the figure is moving toward the Wilbur Spring ravine. Discharge into the ravine takes place principally through three distinct springheads designated Sa 51aSp, Sa 51bSp, and Sa 51cSp. Some discharge occurs also along a relatively continuous seepage line at the outcrop of the sand-clay contact in the ravine. Figure III-11 contains a profile of the ravine showing the position of the sand-clay contact and the position of the different springheads. The discharge of the springheads and the total flow from the ravine in May 1958 also are shown on the profile. Discharge from springheads Sa 51aSp and Sa 51bSp were measured from January to November 1959 at a weir constructed across the stream channel 10 feet downstream from the point where the waters issuing from the two springheads join. Except for two measurements in March 1959 that included overland runoff, the flow at the weir has remained fairly constant at 25-30 gpm (fig. III-8). The total flow from the Wilbur Spring ravine, including the flow of the springheads and seepage, was about 50 gpm on May 15, 1958. A second measurement of the flow from the ravine made on October 15 showed a discharge of about 35 gpm. Although these measurements are accurate to only about ±5 gpm they indicate that there is a decrease in flow along the entire length of the ravine between May and October. That there is no appreciable decrease in flow from springheads Sa 51aSp and Sa 51bSp indicated that the

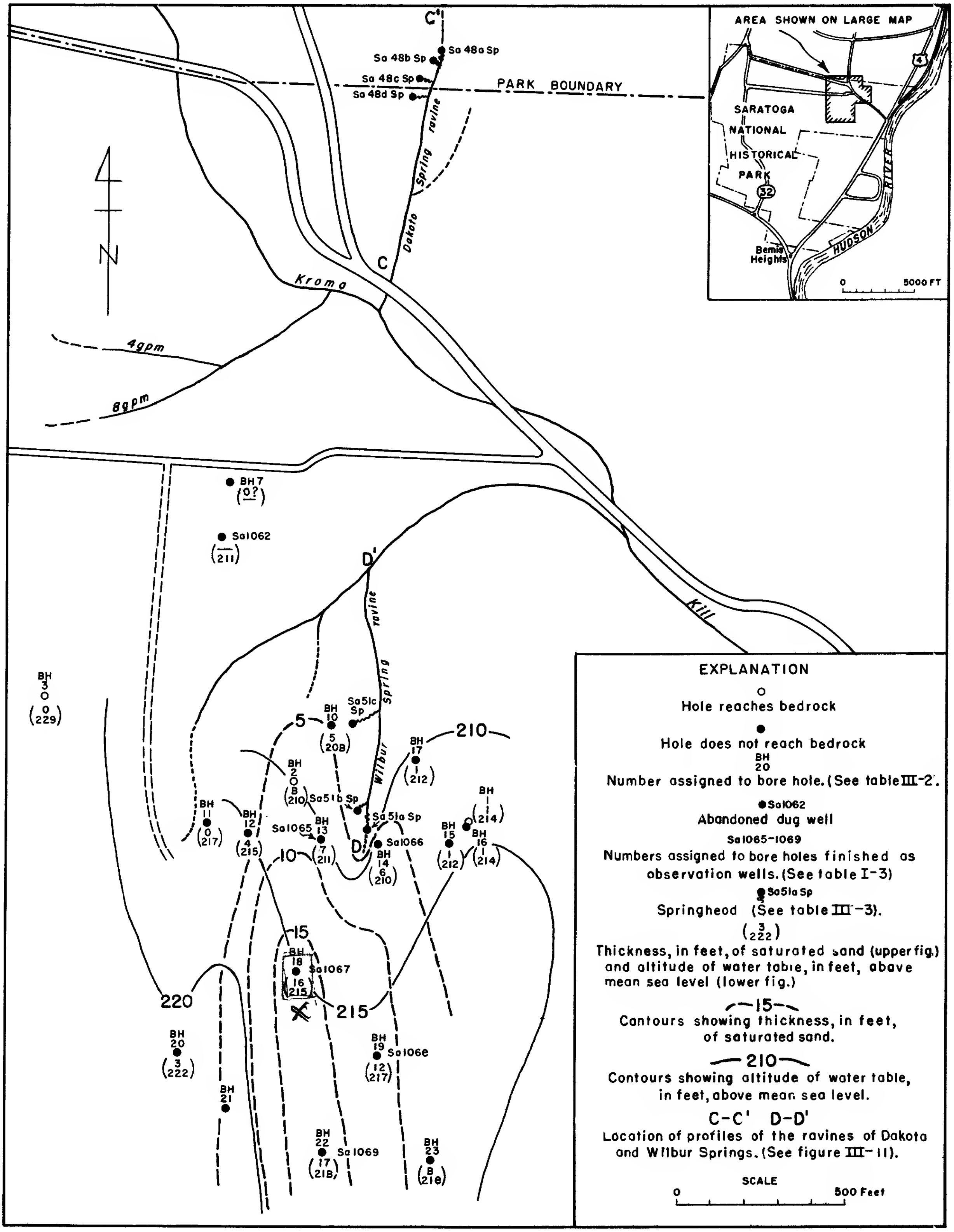

Figure III-10.--Map showing the location of springheads on the Dakota Spring and the Wilbur Spring ravines and the water table and thickness of saturated sand in the vicinity of Wilbur Spring ravine.

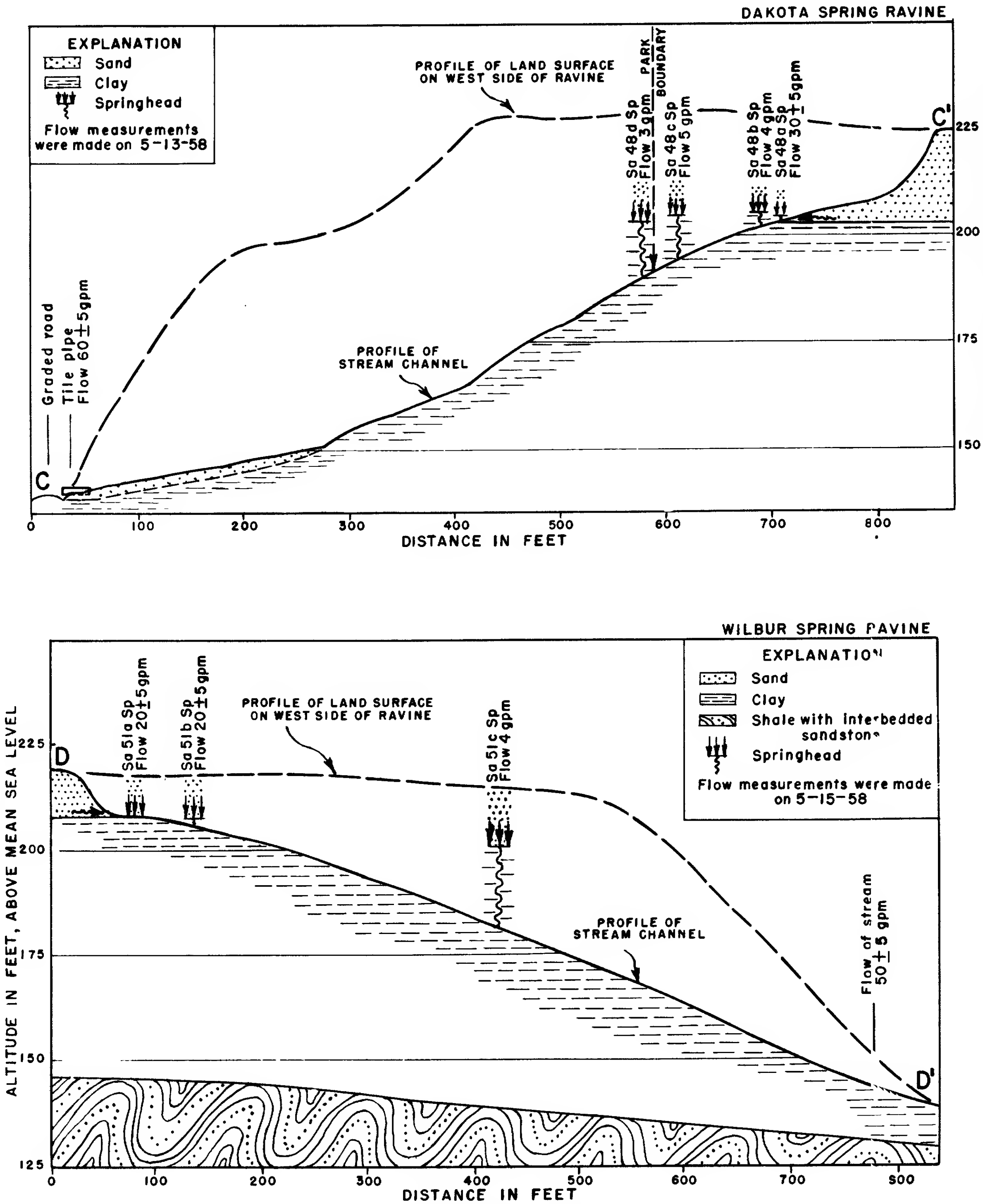

Figure III-11.--Profiles of the Dakota Spring and the Wilbur Spring ravines. (Locations of the lines of the profiles are shown in figure III-10.)

principal reduction in streamflow results from a decrease in seepage along the valley sides. Discharge, temperature, and other data for selected springs in the area, including those along the Wilbur Spring ravine, are contained in table III-3.

Discharge from the segment of the sand deposit which is situated north of the park boundary (fig. I-3) occurs principally at the Dakota Spring ravine. Discharge into this ravine takes place from four major springheads which have developed along the sand-clay contact in a manner similar to the Wilbur Spring ravine (fig. III-11).

During the period from May to October 1958, the flow from the ravine ranged from a high of about 60 gpm in May to a low of about 50 gpm in September. Measurements of flow from the ravine included in table III-3 indicate a decrease in flow during the dry summer of 1959. However, the flow remains substantial even during dry periods and is readily accessible through a tile pipe (fig. III-11). Many of the local residents use water from the spring during dry periods when the yield of their wells becomes inadequate.

Deposits of the Hudson River Valley

Description.--Except where bedrock crops out in a few places, the valley of the Hudson River is underlain by unconsolidated deposits. These deposits range in thickness from zero at outcrops, such as that at Bemis Heights, to more than 100 feet at well Sa 1041. Information obtained from five wells indicates that the deposits consist largely of sand and silt. Thin layers of coarse sand and gravel appear to be irregularly distributed through the deposits. Most of the deposits are believed to have been laid down in Lake Albany and thus are late Pleistocene in age. The deposits in the valley are treated separately from the other stratified deposits of Pleistocene age because little is known about their character and thickness. The uppermost deposits are sand, silt, and clay (together termed "alluvium") that have been deposited by the river in Recent time.

Occurrence of ground water.--Five of the wells shown in figure III-1 are known to draw water from the unconsolidated deposits that underlie the flood plain of the Hudson River. Where these deposits consist of sand or sand and gravel in direct contact with the Hudson River they are probably capable of supplying large quantities of water to wells. The yield of well Sa 1041 is reportedly 60 gpm. Yields of the other wells are not known but are probably less than 15 gpm.

Chemical Quality of Water

Table III-1 contains 6 analyses of water from sand deposits mantling the lower terrace and 2 analyses of water from till. Five of the former were of water from Wilbur and Dakota Springs and one was from a shallow well located about 450 feet southwest of the head of Wilbur Spring ravine. These six samples indicate that water from surficial sand deposits contains much less dissolved solids than water from bedrock. (See analyses of water from spring Sa 51aSp and from wells Sa 827-Sa 829, figure III-4.) The two samples of water from till do not permit characterization of water from that deposit.

Table III-3.--Records of selected springs in Saratoga National Historical Park and vicinity

Spring no.	Location in figure III-1	Owner	Altitude above sea level (feet)	Water-bearing material	Yield: Rate (gpm)	Yield: Date of measurement	Use	Temperature: °F	Temperature: Date of measurement	Remarks
Sa 48Sp	9Y, 6.8E, 0.5N			Pleistocene sand. Water issues from contact of sand overlying clay	60 ±5 60 ±5 55 ±5 55 ±5 50 ±5 45 ±5 40 70 60 50 40 35	5/13/58 6/ 6/58 8/ 5/58 9/ 3/58 9/18/58 10/15/58 1/14/59 1/22/59 3/25/59 5/ 6/59 7/27/59 11/10/59	Unused (See remarks)			Locally known as "Dakota Spring." Discharge measured at culvert on N. side of graded road. Spring consists of four distinct heads designated 48a, 48b, 48c, and 48d. (See following entries.) Chemical analysis in table III-1. Local residents draw water from spring during dry periods.
48a	(See	Raymond Phillips	204		30	5/13/58		47.8	4/18/58	Beginning of perennial stream about 100 ft S. of N. end of steep-sided valley formed by spring sapping. Chemical analysis in table III-1.
48b	fig.	do.	206		4	do.		47.5	5/13/58	
48c	III-10)	do.	205		5	do.		47.2	5/13/58	
48d		U. S. National Park Service	203		3	do.		46.0	5/13/58	
Sa 49Sp	9Y, 7.0E, 0.3S	Adolph Schoen	205	do.	5(Est.)		Domestic	--		Flow is reportedly constant.
Sa 50Sp	9Y, 6.5E, 1.1N	William Doyle	215	do.	6	4/25/58	do.	47.5	4/25/58	
Sa 51Sp	9Y, 6.8E, 0.1N	U. S. National Park Service		do.	50 ±5 35 ±5	5/15/58 10/15/58	Unused (See remarks)			Locally known as "Wilbur Spring." Believed to have served as source of supply for British Army during the battles of Saratoga. Spring consists of three distinct heads designated 51a, 51b, and 51c. (See following entries.) Chemical analysis in table III-1.
51a	(See		208		20 ±5 1/	do.		46.8 52.2 52.5 50.8	5/15/58 8/22/58 9/ 3/58 10/15/58	Beginning of perennial stream about 50 ft N. of S. end of Wilbur Spring ravine. Chemical analysis in table III-1.
51b	fig.		206		20 ±5 1/	do.		--		
51c	III-10)		201		4	do.		--		

1/ The flow of springheads Sa 51aSp and Sa 51bSp measured between 25-30 gpm from Jan. to Nov. 1959 at a weir constructed 10 feet downstream from their junction.

QUANTITATIVE STUDIES

The investigation did not indicate the presence of any source of large ground-water supplies. Measurements of the discharge from the Dakota and Wilbur Spring ravines indicated that the sand deposit supplying the springs was the most productive aquifer in the area. However, as the deposit is relatively thin (generally less than 20 feet thick) and fine grained, it is apparent that the development of moderate quantities of water from it presents certain problems. Chief among these are (1) practical and economical methods for constructing and developing supply wells, and (2) the perennial rate at which such wells can be pumped. To answer these questions test wells were constructed in July and August 1959 in the vicinity of the Wilbur Spring ravine and, following the construction of the wells, a pumping test was conducted to determine the water-bearing characteristics of the deposit.

Construction of Test Wells

As the greatest known thickness of saturated sand in the park is in the vicinity of well Sa 1067 (fig. III-10), about 400 feet southwest of the head of Wilbur Spring ravine, that area was chosen as the site for the test wells and pumping test.

The wells constructed for the pumping test consisted of a pumping well (Sa 1077) and 12 observation wells. The observation wells are located along lines to the north and east of the pumping well. The position of the test wells with respect to each other and with respect to well Sa 1067 and the other wells that were installed in August 1958 are shown in the inset in figure III-12. As can be seen from the figure, two wells were constructed at several of the sites. At these sites, one well was screened near the bottom of the aquifer and the other near the top. The purpose of the dual wells at these sites was to determine the differences, if any, in drawdown between the top and bottom of the aquifer during the pumping test.

Several methods were used in the construction of the wells. Well Sa 1072 is 6 inches in diameter and was drilled by the cable-tool method. The well is finished with a 30-gauze drive point 3 feet in length and 2 inches in diameter imbedded in a coarse sand pack. The other wells that extend to the bottom of the aquifer, wells Sa 1073-Sa 1078, were constructed by jetting a hole to the desired depth with a $1\frac{1}{2}$-inch diameter pipe through which water was pumped under high pressure. A line of 2-inch casing, equipped with a 60-gauze screened drive point 3 feet in length (screened area 2 feet in length), was lowered down the hole at about the same rate as the hole was excavated by the jet pipe. The bottom of the drive point in these wells is from 1 to 2 feet above the clay layer.

The wells that terminate in the top part of the aquifer, Sa 1079-Sa 1084, were constructed by driving a line of $1\frac{1}{4}$-inch casing equipped with a 60-gauze screened drive point 3 feet in length (screened area 2 feet in length) to a depth of 2 to 3 feet below the water table.

In order to develop the observation wells to the point that they would be fully responsive to changes in water level in the aquifer, water was pumped under pressure into all wells except Sa 1072. Next, water was

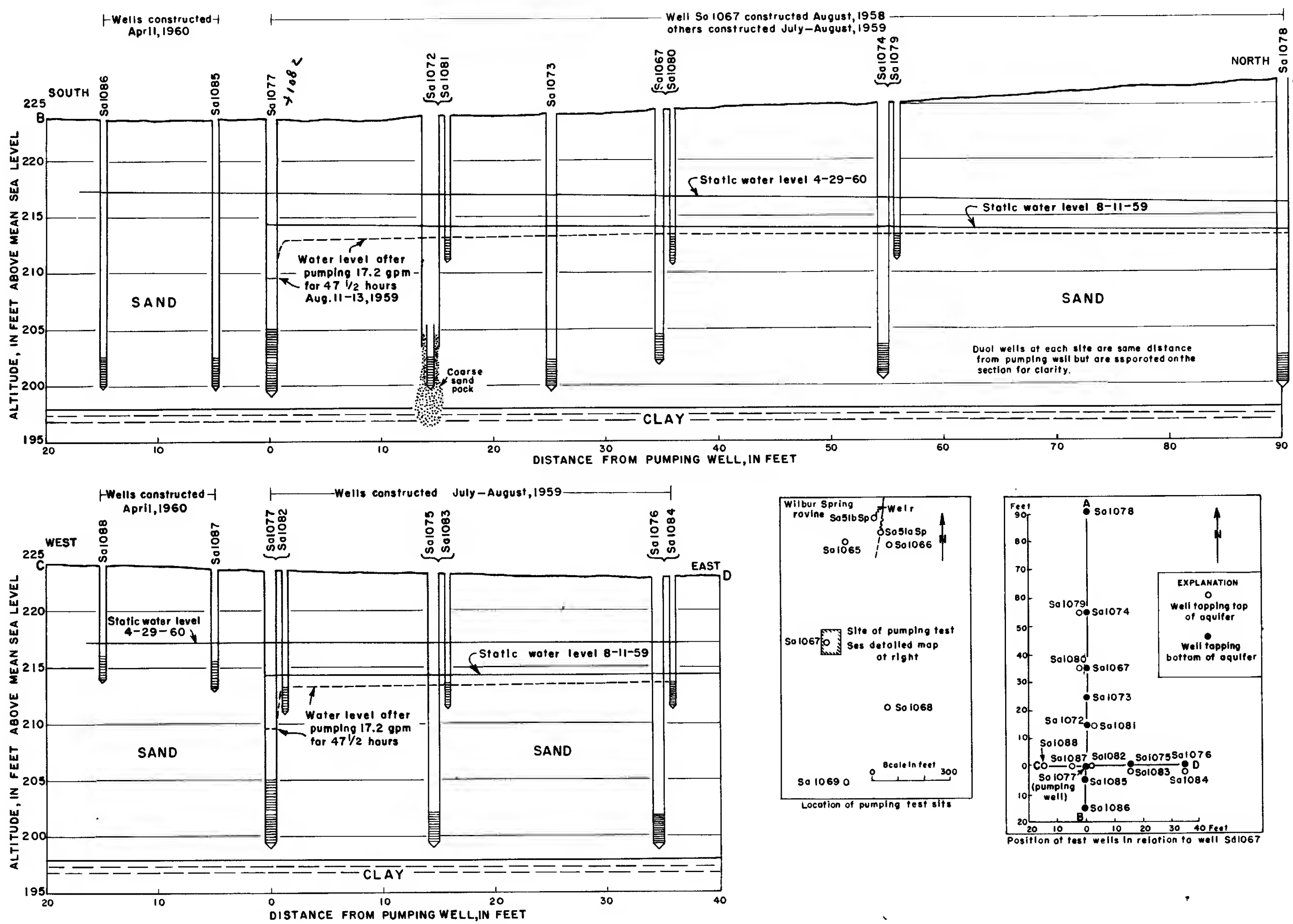

Figure III-12.--Sections and maps showing the wells used in the pumping test of August 11-13, 1959, and the step-drawdown test of April 29, 1960. (All wells except Sa 1085-Sa 1088 were measured in the first test; all wells were measured in the step-drawdown test except Sa 1075, Sa 1076, Sa 1083, and Sa 1084.)

pumped from the wells until it became clear. Several of the test wells constructed by the jetting method were test-pumped at a rate as high as 35 gpm for periods as long as 30 minutes.

The pumping well, well Sa 1077, was constructed by the jetting method. The well is 2 inches in diameter and is equipped with a drive point having a screened area 5.5 feet long of 60 gauze. The well is 24.1 feet deep, and the bottom of the screen is about 2 feet above the clay layer.

Figure III-12 is a section through the wells showing the relative position of the screens, the water table, and the bottom of the aquifer.

Pumping Test of August 10-13, 1959

The withdrawal of water from an aquifer causes water levels to decline in the vicinity of the point of withdrawal. As a result of this decline, the water table in the vicinity of the well assumes the approximate shape of an inverted cone having its apex at the well. The size, shape, and rate of growth of this "cone of depression" depend on several factors. Among these are: (1) the water-transmitting and water-storing capacities of the aquifer, (2) the rate and duration of pumping, (3) the increase in recharge resulting from the decline in water levels, and (4) the amount of natural discharge salvaged by the pumping. The distance that water levels are lowered at any point by the pumping is termed "drawdown." The drawdown is more or less proportional to the pumping rate.

To determine the water-bearing characteristics of the sand deposit, well Sa 1077 was pumped at a constant rate of 17.2 gpm for 47 hours and 38 minutes, from 10:47 a. m., August 11, to 10:25 a. m., August 13, 1959. The water pumped during the test was discharged into the Wilbur Spring ravine through a pipeline approximately 475 feet long. This was done to prevent the water pumped from the well from recharging the aquifer. The extent to which the pumping lowered the water levels in the aquifer was determined from measurements in the observation wells. A continuous record of the water level in well Sa 1072 was obtained with an automatic recording gage installed on the well. Figure III-13 shows water-level measurements for selected wells before, during, and after the pumping test. Drawdowns after 47 hours of pumping ranged from about 1.0 foot in well Sa 1072, 15 feet north of the pumping well, to about 0.3 foot in well Sa 1078, 90 feet north of the pumping well.

Analysis of Data

The drawdowns produced by the pumping were analyzed to determine the transmissibility and the storage coefficient of the sand deposit. The transmissibility is a measure of the ability of an aquifer to transmit water and is expressed in gallons per day per foot. In effect it is equal to the permeability multiplied by the saturated thickness of the aquifer. The storage coefficient is the quantity of water in cubic feet released from storage in a vertical column of the aquifer having a base of 1 foot square when the water level in the aquifer is lowered 1 foot. The coefficient of storage is expressed as a dimensionless fraction.

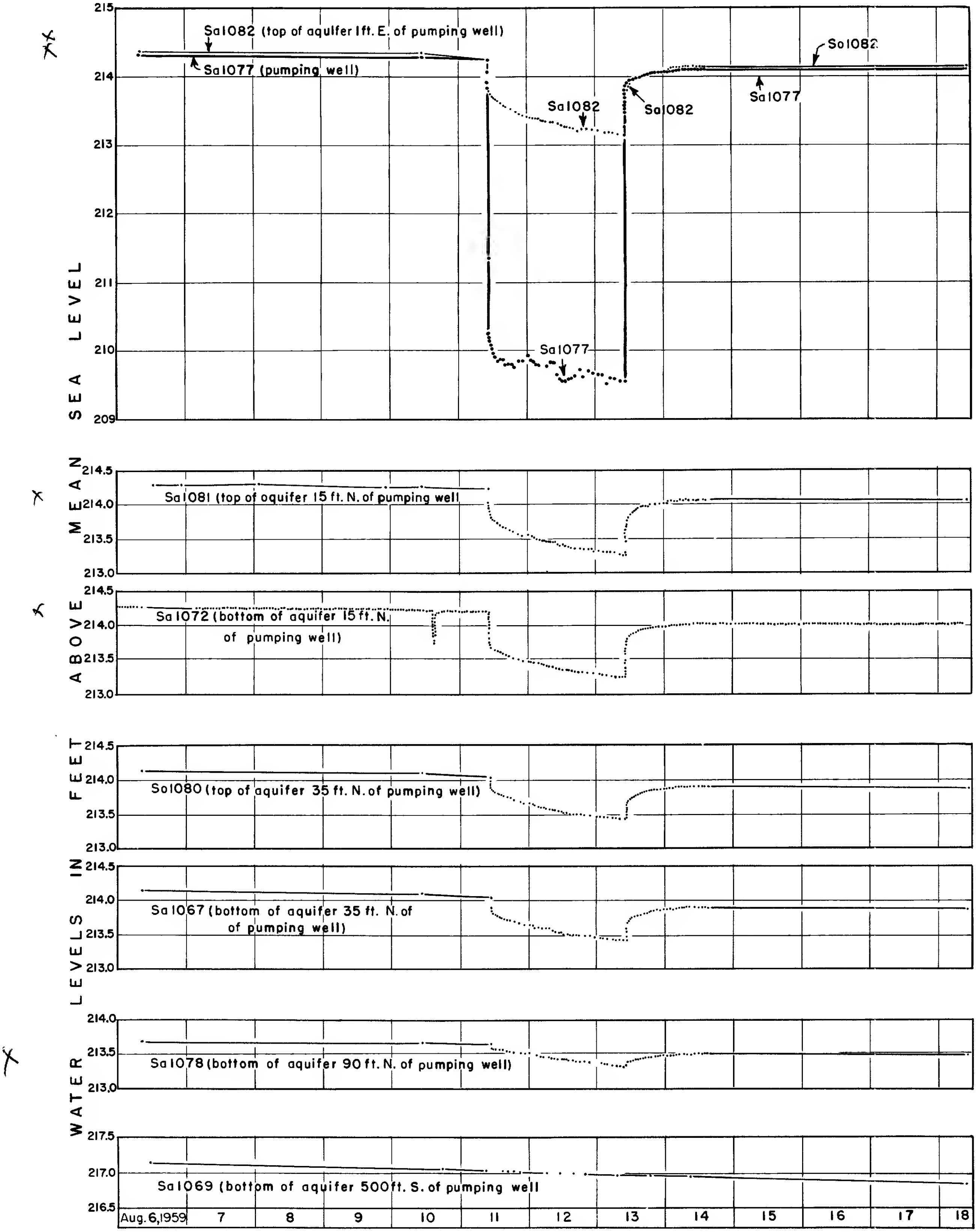

Figure III-13.--Hydrographs of the pumping well and selected observation wells in the vicinity of the Wilbur Spring ravine showing response of the water level during the pumping test of August 11-13, 1959. (Well Sa 1077 was pumped at a rate of 17.2 gpm from 10:47 a. m., August 11 to 10:25 a. m., August 13.)

Before analyzing the water-level data collected during the pumping test it was necessary to correct for the seasonal decline of the water table. This decline is apparent in both figure III-8 and figure III-13. The decline was determined to be approximately 0.02 foot per day at the pumping-test site. The water-level data were also corrected for the decrease in the saturated thickness of the aquifer during the pumping test using a method devised by Jacob (1944). The amount subtracted from the drawdown because of dewatering of the aquifer was determined by Jacob to be equal to $s^2/2m$; where "s" is the drawdown and "m" is the saturated thickness. The magnitude of the corrections for seasonal decline and dewatering may be illustrated with data from well Sa 1072, which is open to the bottom of the aquifer 15 feet north of the pumping well. The uncorrected drawdown after 2,825 minutes of pumping was 0.97 foot. After correction for seasonal decline (0.04 foot) and dewatering of the aquifer (0.03 foot) the actual drawdown produced by the pumping was determined to be 0.90 foot.

Prior to the test, it was anticipated that the drawdown data would also have to be corrected for the effect of partial penetration of the pumping well. The pumping well, Sa 1077, was screened through approximately the lower third of the aquifer, from 2 feet to 7 feet above the bottom of the aquifer (fig. III-12). As a result, observation wells screened in the lower part of the aquifer were expected to show greater drawdowns than the wells screened in the upper part. For an isotropic aquifer (an aquifer that has the same permeability in all directions) the differences in drawdown between top and bottom are negligible at a distance from the pumping well equal to twice the thickness of the aquifer. (See Muskat, 1946, p. 271.) The effect of partial penetration in a stratified aquifer such as that in the park will extend to a distance considerably greater than twice the thickness. Observations of drawdowns during the pumping test showed that during the early part of the test drawdowns in the shallow wells lagged behind those in the deeper wells as expected (fig. III-13). However, as the test proceeded the drawdowns converged and at the end of the test they were essentially the same in both the bottom and the top of the aquifer in all wells except those 15 feet from the pumping well and closer. Thus, it was not possible to correct the drawdowns for the effects of partial penetration.

The gradual convergence of the water levels in the top and bottom of the aquifer is an anomalous situation. It is suspected that the explanation is to be found in the method used in constructing the deeper wells. During the process of jetting these wells, the finer particles were doubtless removed for some distance around the wells leaving an envelope of coarse sand around the wells. As a result, the deeper observation wells responded as though they were screened throughout the entire saturated thickness of the aquifer. A further study of the effects of partial penetration was made on April 29, 1960, during a "step-drawdown test" whose primary purpose was to examine well losses. The results of this test indicate that the explanation suggested above is correct. Details of the step-drawdown test will be given in a later section.

The coefficients of transmissibility and storage were determined by analyzing the drawdowns using a method devised by Theis and described by Wenzel (1942, p. 87-90). The method involves the following formula which

relates the drawdowns in the vicinity of a discharging well to the rate and duration of the discharge:

$$s = \frac{114.6Q}{T}\int_{u}^{\infty} \frac{e^{-u}}{u}\,du = \frac{114.6Q}{T} W(u),$$

where: $u = \dfrac{1.87\ r^2 S}{Tt}$,

s = drawdown, in feet, at any point,
r = distance, in feet, from pumping well to the point at which the drawdown is "s,"
Q = discharge of the well, in gallons per minute,
t = time of pumping, in days, required to produce the drawdown "s" at the distance "r,"
T = coefficient of transmissibility, in gpd/ft (gallons per day per foot),
S = coefficient of storage, a dimensionless fraction,
W(u)= replaces the integral expression and is called "well function of u," and
e = natural-logarithm base.

The formula is based on certain simplifying assumptions, which include the assumptions that the aquifer is constant in thickness, infinite in areal extent, homogeneous, and isotropic (has the same permeability in all directions). It is assumed also that there is no recharge to the formation or discharge other than that from the one well within the area of influence of the well, and that water may enter the well throughout the full thickness of the aquifer.

To determine T and S the drawdown in the wells is plotted against t/r^2 on transparent log-log paper. The resulting curve is a segment of the "type curve" produced by plotting the log of the exponential integral, W(u), against the log of the quantity 1/u. The curve of observed data is superposed on the type curve and the values of 1/u, W(u), s, and t/r^2 are selected for any convenient match point. These values are inserted in the formulas for "s" and "u," given above, in order to determine the coefficients of transmissibility (T) and storage (S). The method described above is clearly illustrated in a paper by Brown (1953, p. 851-858).

Figure III-14 is a plot of corrected drawdowns versus t/r^2 for the five observation wells screened in the bottom of the aquifer north of the pumping well. The drawdowns for well Sa 1072 were obtained by reading the tape of a float-actuated recording gage. The drawdowns for all other wells were determined from hand-tape measurements. As a result, the drawdowns in well Sa 1072 throughout the test follow a relatively smooth curve whereas the drawdowns in the other wells have a considerable scatter which is obviously due to small errors in measurement. Only the measurements for wells Sa 1067, Sa 1073, Sa 1074, and Sa 1078, which plot to the right of the type curve indicating artesian conditions, are shown in figure III-14.

Figure III-14 shows that the drawdown data and the type curve may be matched at two distinctly different positions. The match using the drawdown in well Sa 1072 during the first 4 minutes of the test indicates a coefficient

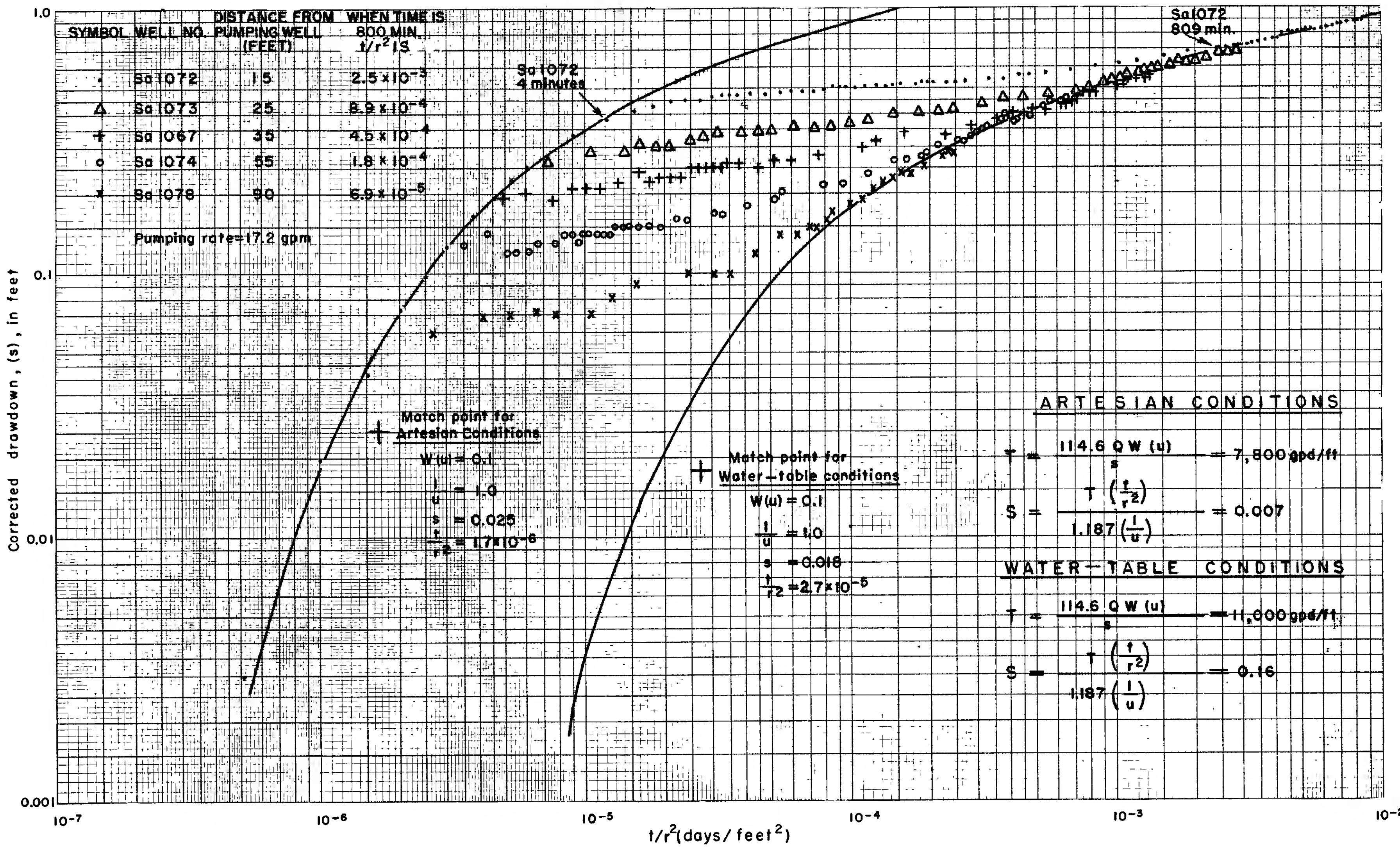

Figure III-14.--Plot of log of drawdowns versus log of t/r^2 in the five observation wells screened in the bottom of the aquifer north of the pumping well. The drawdowns are corrected for seasonal decline and dewatering of the aquifer.

of transmissibility of about 7,800 gpd/ft and a coefficient of storage of 0.007. This low coefficient of storage indicates artesian conditions. After approximately 4 minutes the data for well Sa 1072 began to diverge from the type curve. Approximately 800 minutes (13.3 hours) after pumping started the data for well Sa 1072 again started to follow a segment of the type curve. However, as may be observed from the figure, a match of the data with the type curve requires a displacement of the type curve of a little more than one log cycle to the right. Substitution of the values of $W(u)$, $1/u$, s, and t/r^2 at the new match point into the formulas for transmissibility and storage results in values of 11,000 gpd/ft for "T" and 0.16 for "S." The value of the storage coefficient at this match point indicates water-table conditions. The preceding discussion is based on the data for well Sa 1072. As shown in figure III-14 the data for the other wells generally follow the same pattern as those for well Sa 1072. After 800 to 1,000 minutes of pumping the drawdowns in each of the wells began to follow the type curve at the match position indicating water-table conditions. As the saturated thickness of the aquifer at well Sa 1077 was approximately 16 feet at the time of the test, the permeability of the sand deposit (T/m) is about 700 gpd/ft^2. The data indicate that the character of the deposit is similar throughout the park and vicinity. Thus, it appears the yield of wells drawing from the deposit in the area can be predicted within reasonable limits by using the appropriate formulas and by assuming the transmissibility is equal to the saturated thickness multiplied by 700 and the storage coefficient is 0.16.

In summary, during the first 4 minutes of the test the aquifer responded as an artesian aquifer. This response is doubtless the result of the stratification of the aquifer--that is, the alternation in the aquifer of thin horizontal layers of silty fine sand and somewhat thicker layers of medium to coarse sand. As a result of the stratification, the permeability in a vertical direction is considerably lower than in the horizontal direction causing the aquifer to respond initially as though it were artesian. From about 4 minutes to about 800 minutes the aquifer went through a transition from artesian to water-table conditions. From about 800 minutes to the end of the test the aquifer responded as a water-table aquifer. It may be noted that methods presently available for the analysis of pumping-test data are not applicable during the period of transition from artesian to water-table conditions. It may also be noted that the transmissibility increased from about 7,800 gpd/ft to 11,000 gpd/ft during the transition from artesian to water-table conditions. This increase suggests that during the first few minutes of the test all the water being pumped was being supplied by the lower 70 percent of the aquifer.

Observation wells were located both to the north and to the east of the pumping well. The wells were constructed along perpendicular lines in order to determine if the horizontal permeability varies in different directions. Such differences in permeability are not uncommon. Water-level measurements made immediately prior to the test (fig. III-12) show that ground water at the pumping-test site was moving almost due north. Thus, the observation wells north of the pumping well were located on a line essentially parallel to the direction of ground-water flow. Conversely, the wells east of the pumping well were located on a line perpendicular to the direction of flow. The drawdowns during the test were found to be exactly the same at equivalent distances and times to the north and to the east of the pumping well

indicating that the horizontal permeability is the same in all directions within the area encompassed by the observation wells.

The decrease in drawdown with increasing distance from the pumping well is shown in figure III-15. The water-level measurements used in the

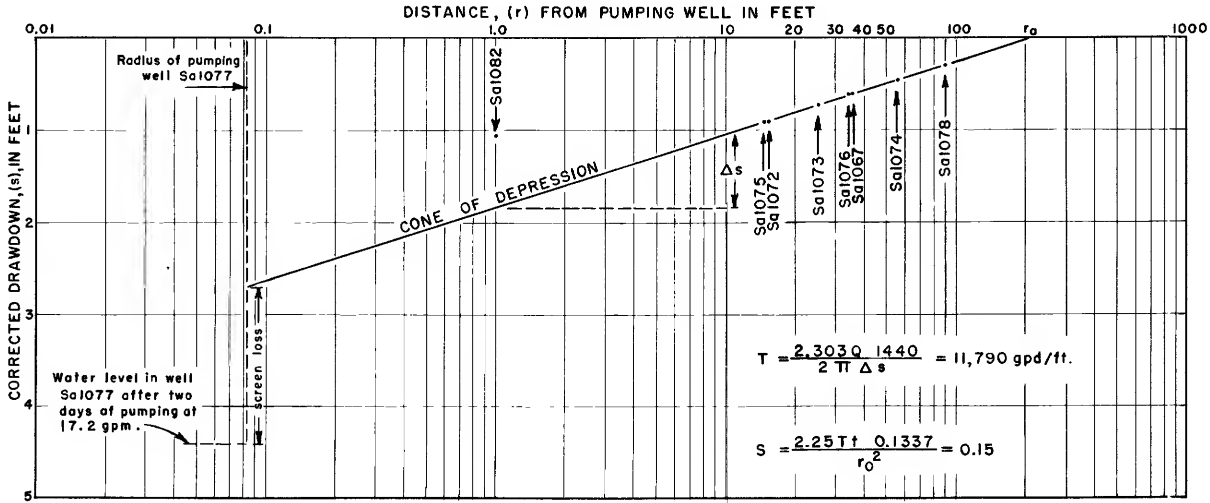

Figure III-15.--Graph of drawdowns versus log of distance from pumping well. (Measurements of drawdowns were made after 2 days of pumping at 17.2 gpm. The drawdowns are corrected for seasonal decline and dewatering of the aquifer.)

figure were made a few minutes before the pump was cut off. It may be noted that the cone of depression is a straight line on the semi-logarithmic paper used in drawing the figure. Computations of transmissibility and storage using formulas devised by Cooper and Jacob (1946, p. 526-534) from the Theis equation are also shown in the figure. As can be seen, they compare favorably with the results obtained using the type curve and Theis equation. The drawdown in the formation outside of the pumping well can be determined by extending the line representing the cone of depression to the vertical line representing the radius of the pumping well. As shown in figure III-15, this drawdown is 2.7 feet. The drawdown inside the pumping well, however, was 4.4 feet. The difference of 1.7 feet represents the head lost in moving water through the screen into the well. This loss in head is referred to as "screen loss."

Step-Drawdown Test of April 29, 1960

Screen losses occur where the screen face, with sand particles clogging some of the screen openings, is less permeable than the formation. The screen loss in any well varies with the pumping rate. Where the flow through the screen is laminar--that is, where the stream lines remain distinct from one another--the loss is in direct proportion to the discharge. On the other hand, where the flow is turbulent--that is, when the stream lines are thoroughly confused through heterogeneous mixing--the screen loss varies approximately with the square of the discharge (Rorabaugh, 1953).

To determine how the screen losses in a well tapping the sand aquifer at the park vary with changing pumping rates a step-drawdown test was conducted on well Sa 1077 on April 29, 1960. The step-drawdown test which was developed by Jacob (1947) to determine both screen loss and effective well radius, involves pumping a well at three or more rates, preferably in even increments, and measuring the drawdown in the pumping well. Because a line of observation wells already existed at the site, measurements of drawdown were also made in those wells. The use of the measurements simplified the analysis of the data. As a side product of the test it was decided to reexamine the effects of partial penetration in order to determine whether the apparent lack of partial-penetration effects in the test of August 1959 was due to well construction. Four new observation wells were constructed by driving a line of casing equipped with a screened drive point into the sand. Wells Sa 1085 and Sa 1086 were driven to the bottom of the aquifer 5 feet and 15 feet, respectively, south of the pumping well, Sa 1077. Wells Sa 1087 and Sa 1088 were driven into the top of the aquifer 5 feet and 15 feet, respectively, west of the pumping well. (The locations of and sections through these wells are shown in figure III-12.)

Well Sa 1077 was pumped at rates of 4.7, 11.2, 19.4, and 20.0 gpm for 50 minutes at each rate. The maximum quantity of water that the centrifugal pump used for the test could pump through the suction and discharge system (which consisted of a check valve, 1-inch diameter suction pipe, positive displacement watermeter, and approximately 100 feet of 2-inch diameter discharge hose), was 20 gpm. Therefore, in an attempt to increase the discharge the pump was shut off and the watermeter and part of the discharge line were disconnected. However, this resulted in an increase of only 1 gpm. Next the check valve and drop pipe were removed from the well and the suction line was attached directly to the well casing. Starting 31 minutes after the end of step 4 the well was pumped for 50 minutes at 50 gpm. This is designated as step 5 in the following discussion. As no measurements of the drawdown in the pumping well were possible during step 5, it is assumed for purposes of computation that the pumping level was about at the top of the screen, resulting in a drawdown of about 12 feet.

The drawdowns during the step-drawdown test in the wells tapping the bottom of the aquifer are shown in figure III-16. The lines connecting the drawdown in the wells give the drawdown in the formation outside of the screen. The drawdown outside the screen is known as "formation loss." The screen loss--that is, the head lost in moving water through the screen--is obtained by subtracting the formation loss from the drawdown in the pumping well. A summary of the data obtained from the step-drawdown test is given in table III-4.

Figure III-17 shows a log plot of screen loss versus discharge. As can be seen from the plot all steps (except step 5) fall on a straight line. This fact suggests a direct relationship between screen loss and discharge through step 4. Such a direct relationship indicates that screen losses for discharges up to and including 20 gpm on well Sa 1077 occur under conditions of laminar flow. It may be observed that the calculated well loss for step 5 plots about 2½ feet below a continuation of the straight line through steps 1 to 4. This suggests that the drawdown in the pumping well was at least 2½ feet below the top of the screen during step 5.

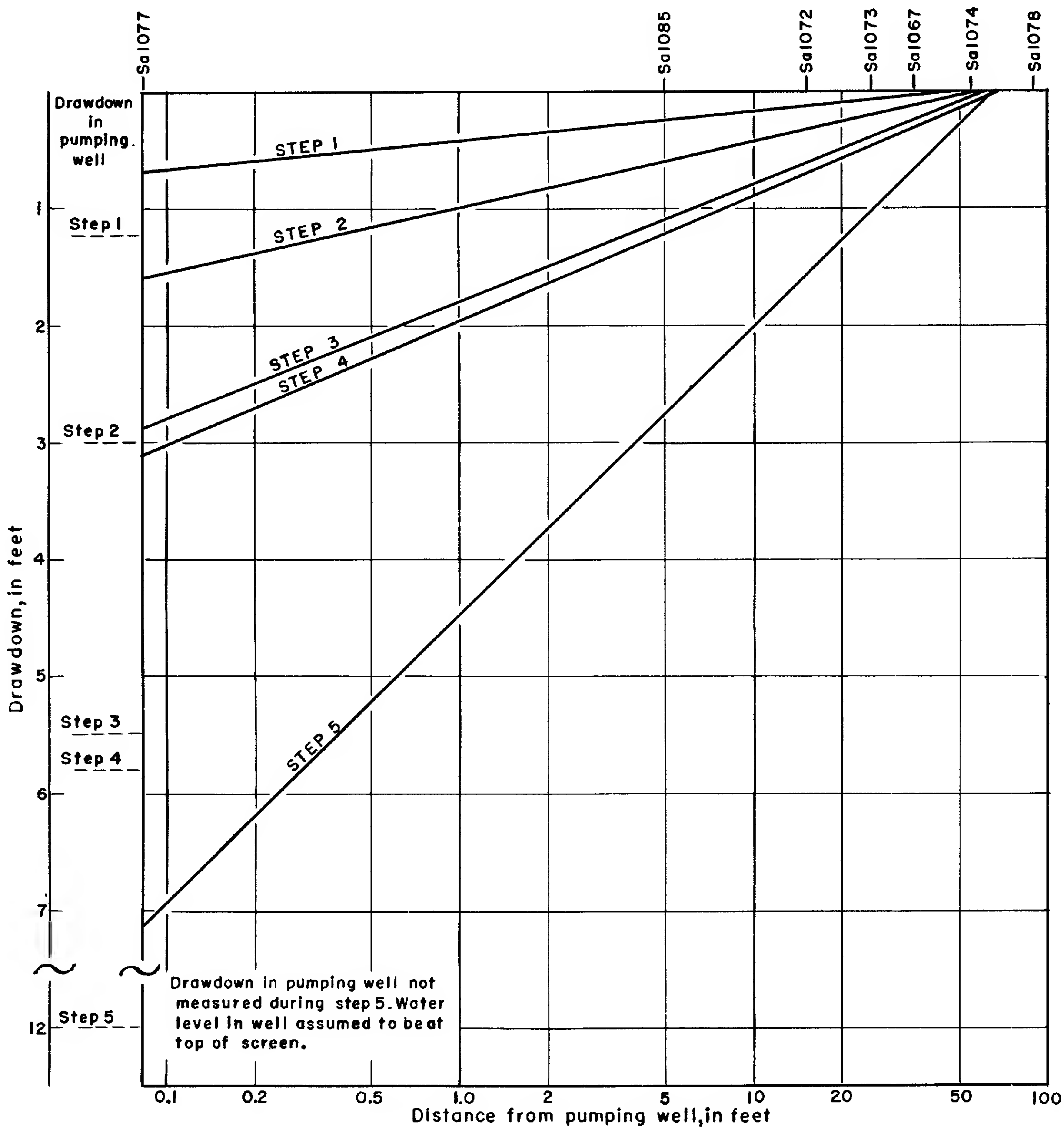

Figure III-16.--Graphs of the drawdowns versus log of distance from pumping well for the step-drawdown test of April 29, 1960. (The drawdowns are not corrected for dewatering of aquifer.)

The screen loss at the end of the 2-day pumping test of August 10-13, 1959, in which well Sa 1077 was pumped at 17.2 gpm, was greater at the same rate of discharge in 1960 than in 1959. The increase in screen loss may indicate compaction of the materials around the well.

Table III-4.--Results of step-drawdown test of April 29, 1960

Step no.	Time in minutes since pumping began	Pumping rate (gpm)	Total drawdown in pumping well (feet)	Formation loss (feet)	Screen loss (feet)
1	0-50	4.7	1.22	0.69	0.53
2	50-100	11.2	2.99	1.59	1.40
3	100-150	19.4	5.49	2.87	2.62
4	150-200	20.0	5.80	3.09	2.71
5 a/	231-277	50	12 b/	7	5

a/ A period of 31 minutes elapsed between the end of step 4 and the beginning of step 5. Between 6 and 16 minutes after the end of step 4 the well was pumped at 21 gpm.

b/ Water level is estimated to be at top of well screen.

As mentioned previously, the step-drawdown test provided a means to reexamine the effects of partial penetration. Table III-5 contains the drawdowns in the wells tapping the bottom and the top of the aquifer at different distances from the pumping well. The drawdown in the shallow well Sa 1087 at a distance of 5 feet was considerably less than the drawdown in the equally distant deep well, Sa 1085, throughout the test. Similarly, the drawdown in shallow well Sa 1088 at a distance of 15 feet was considerably less than the drawdown in equally distant deep well Sa 1086 at the end of the test. The difference in drawdown between the wells in the bottom and top of the aquifer 15 feet south and west of the pumping well was considerably greater than the difference in drawdown in the wells in the bottom and top of the aquifer 15 feet north of the pumping well. (Compare wells Sa 1086 and Sa 1088 with Sa 1072 and Sa 1081.) The differences in drawdown between these wells clearly show that the method of well construction explains why effects of partial penetration were not observed during the pumping test of August 1959. No attempt has yet been made to analyze the data collected in April 1960 to determine the difference in vertical and horizontal permeability. It is probable that the full effect of the permeability difference has not yet been observed because even in the process of driving a well the stratification of the material around the well is disturbed enough to modify the permeability immediately around the well.

Yield of the Sand Deposit

Because the sand deposit responds as a water-table aquifer after a period of several hours of continuous pumping, only the value of transmissibility of 11,000 gpd/ft and storage coefficient of 0.16 determined for water-table conditions are of practical significance. The value of transmissibility indicates that a vertical section of the aquifer 1 foot wide

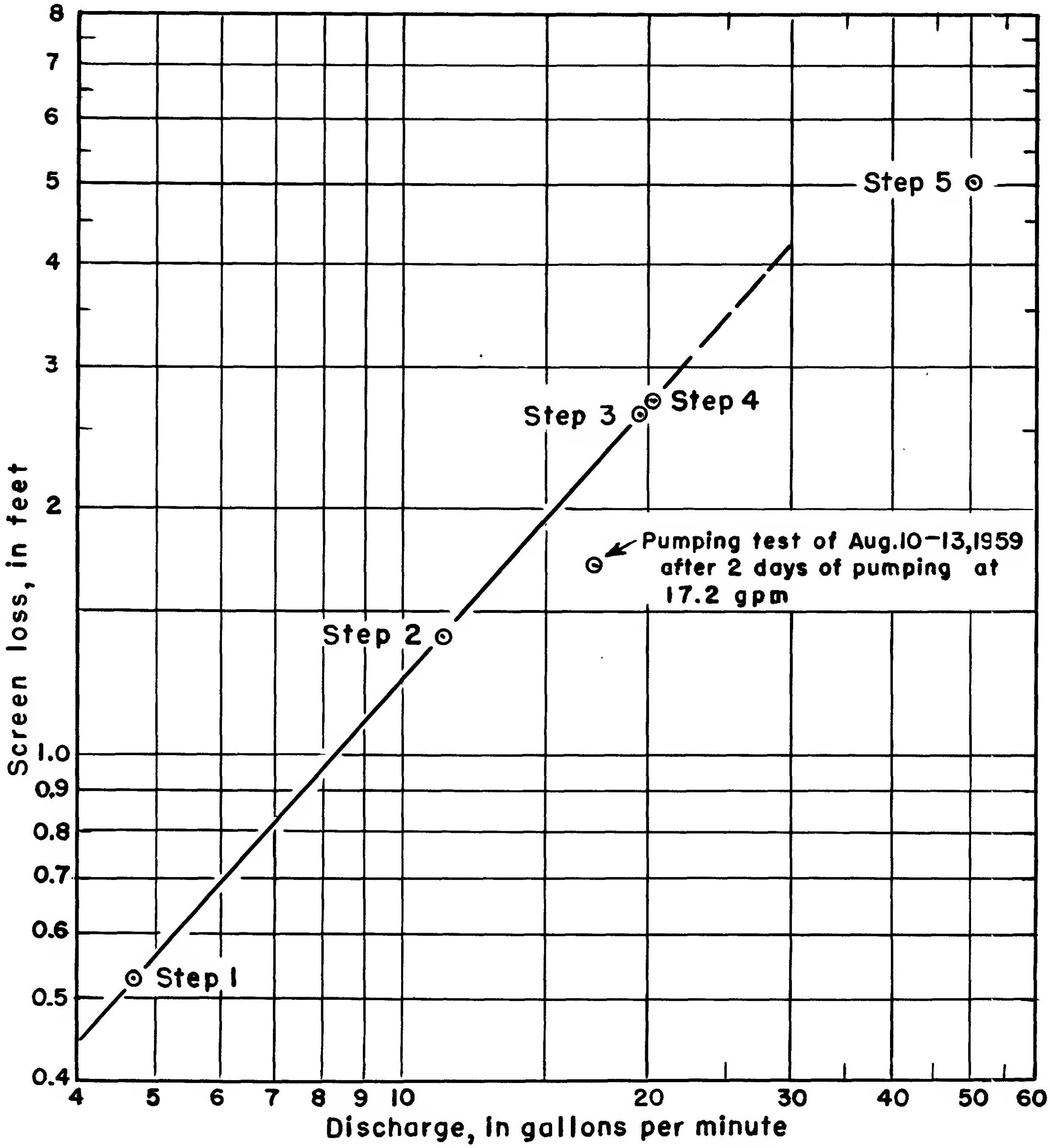

Figure III-17.--Log plot of screen loss versus discharge during the step-drawdown test of April 29, 1960.

will transmit 11,000 gallons of water in one day under a hydraulic gradient of 1 foot per foot. The value for the storage coefficient indicates that a vertical column of the aquifer 1 foot square will yield 0.16 cubic feet (1.2 gallons) of water when the water table is lowered 1 foot.

Substituting the transmissibility (T), storage coefficient (S), pumping rate (Q), and an assumed value for time (t) in the formulas derived from the Theis equation by Cooper and Jacob (1946, p. 526-534), it is possible to

Table III-5.--Comparison of drawdowns in wells tapping bottom and top of aquifer during step-drawdown test of April 29, 1960

Step	Pumping rate in gpm and interval, in minutes, over which rate prevailed	Approximate time since pumping began (minutes)	Uncorrected drawdown, in feet														
			Sa 1085 bottom (S 5 ft) a/	Sa 1087 top (W 5 ft)	Difference	Sa 1086 bottom (S 15 ft)	Sa 1088 top (W 15 ft)	Difference	Sa 1072 bottom (N 15 ft)	Sa 1081 top (N 15 ft)	Difference	Sa 1067 bottom (N 35 ft)	Sa 1080 top (N 35 ft)	Difference	Sa 1074 bottom (N 55 ft)	Sa 1079 top (N 55 ft)	Difference
1	4.7 (0-50)	15 40	0.29 .26	0.05 .09	0.24 .17	0.13 .15	0.03 .05	0.10 .10	0.12 .13	0.09 .10	0.03 .03	0.05 .06	0.04 .05	0.01 .01	-- --	-- --	-- --
2	11.2 (50-100)	70 90 b/	.60 .65	.19 .24	.41 .41	.33 .39	.13 .18	.20 .21	.31 --	.15 --	.16 --	.14 --	.11 --	.03 --	0.06 --	0.05 --	0.01 --
3	19.4 (100-150)	125 145	1.09 1.10	.40 .45	.69 .65	.63 .64	.30 .34	.33 .30	.58 .60	.44 .46	.14 .14	.27 .30	.22 .24	.05 .06	.13 .16	.12 .14	.01 .02
4	20.0 (150-200)	185	1.21	.56	.65	.74	.44	.30	.68	.55	.13	.35	.30	.05	.19	.18	.01
5	50 (231-277) c/	255 275	2.69 2.75	.94 1.05	1.75 1.70	1.56 1.58	.70 .81	.86 .77	1.47 1.54	1.06 1.14	.41 .40	.69 .66	.53 .60	.16 .06	.35 .41	.28 .35	.07 .06

a/ Direction and distance from pumping well.

b/ Pumping rate increased to 11.8 gpm from 79 to 100 minutes. This increase is ignored in analysis for screen loss. Drawdown at end of step 2 is projected on the basis of drawdown from 50 to 79 minutes. Rate is assumed to be 11.2 gpm throughout step 2.

c/ Pump was off from 200 to 231 minutes during removal of suction pipe from the pumping well.

predict the shape and size of the cone of depression resulting from pumping. For example, figure III-18 shows the predicted drawdowns resulting from pumping at rates of 10 gpm and 30 gpm continuously for periods of 2 days and 200 days. The pumping rate of 10 gpm was chosen to show the effect of residential use including substantial quantities for lawn irrigation. The rate of 30 gpm is based on the anticipated needs at the park and on the needs of many small industries and commercial establishments. The period of 2 days was chosen to show the effect of withdrawals over a weekend. The period of 200 days was chosen to show the extent that water levels would be lowered during a prolonged period without recharge. Figure III-18 may be used to determine the drawdowns that would be produced by any number of wells pumping at the indicated rates for periods of 2 and 200 days. For example, the drawdown 1 foot from the center of each of 2 wells spaced 100 feet apart after 200 days of pumping at a rate of 30 gpm would be 7.8 feet. This drawdown is the sum of the drawdown (5.8 feet) produced at a distance of 1 foot from a pumping well by that well and the drawdown (2.0 feet) produced at that point by another pumping well 100 feet away. The drawdown inside the pumping well depends on the diameter of the screen and the "screen loss." The screen losses shown for a pumping well 2 inches in diameter were obtained from figure III-17 on the assumption that screen losses are directly proportional to discharge up to a discharge of 30 gpm. The screen losses predicted for a 6-inch well (in which the circumference of the screen is 3 times that of a 2-inch well) are one third those of a 2-inch well at the same discharge. Thus a well 2 inches in diameter equipped with 5 feet of 60-gauze screen and pumped at a rate of 30 gpm for 200 days without recharge would have a drawdown of about 13 feet while a well 6 inches in diameter also equipped with 5 feet of 60-gauze screen and pumping at the same rate for the same period of time would have a drawdown of about $8\frac{1}{2}$ feet.

The drawdowns predicted in figure III-18 are based on the assumption that the cone of depression does not reach either a recharging or discharging boundary (i.e. that all water pumped is drawn from storage in the aquifer). However, the cone of depression of a pumping well in the vicinity of well Sa 1077 will reach the uppermost springheads on Wilbur Spring ravine after about 10 days of pumping and, thereafter, a part of the water pumped will be derived from a decrease in the flow of the springs. As a result, drawdowns resulting from the pumping will be smaller than those predicted by an amount proportional to the quantity of water that is salvaged from the springs' discharge. The amount by which the flow of the springs will be diminished cannot be predicted but it seems unlikely that it will be excessive.

As most supply wells are operated at the maximum possible rate only for short periods of time, it is frequently useful to know how the drawdown changes with time. Figure III-19, also based on formulas by Cooper and Jacob (1946), shows the increase in drawdown with time for a well 2 inches in diameter being pumped at 30 gpm continuously for 200 days during which there is no recharge to the aquifer. The figure shows the various components that contribute to the total drawdown in the pumping well. It may be observed that the drawdown reaches 10 feet after pumping at a rate of 30 gpm for 1.2 days. This is the maximum length of time that the well 2 inches in diameter could be pumped at a rate of 30 gpm if screened through the lower 5 feet of an aquifer having a saturated thickness of

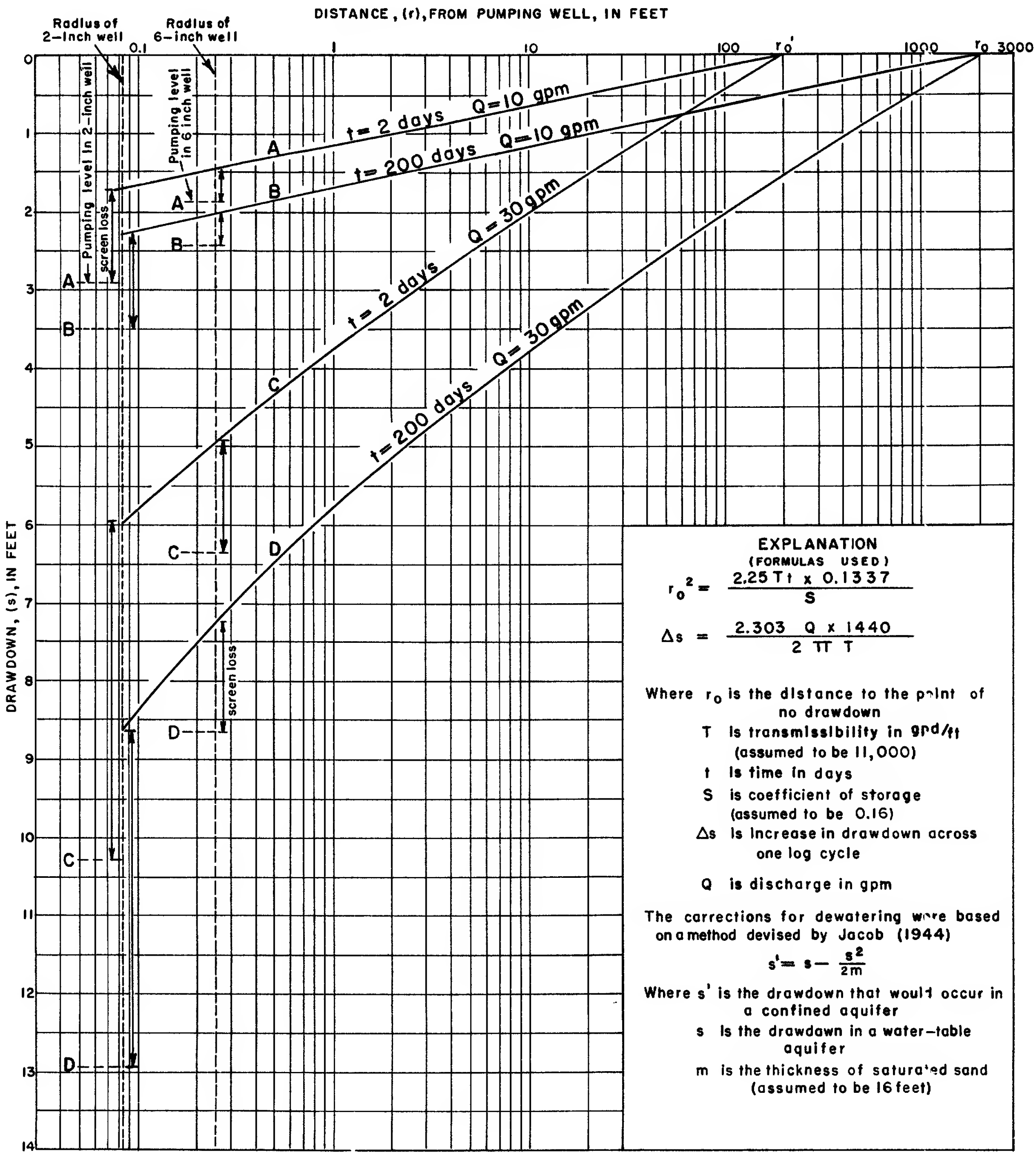

Figure III-18.--Graphs of the predicted drawdowns that would be produced by a well drawing from the sand deposit in Saratoga National Historical Park and vicinity. (The drawdowns have been corrected for dewatering of the aquifer.)

16 feet. The well could continue to be pumped, however, at a lower rate. A 6-inch well with the same screen length would probably have about 3.5 feet less drawdown for the same period. (See figure III-18.)

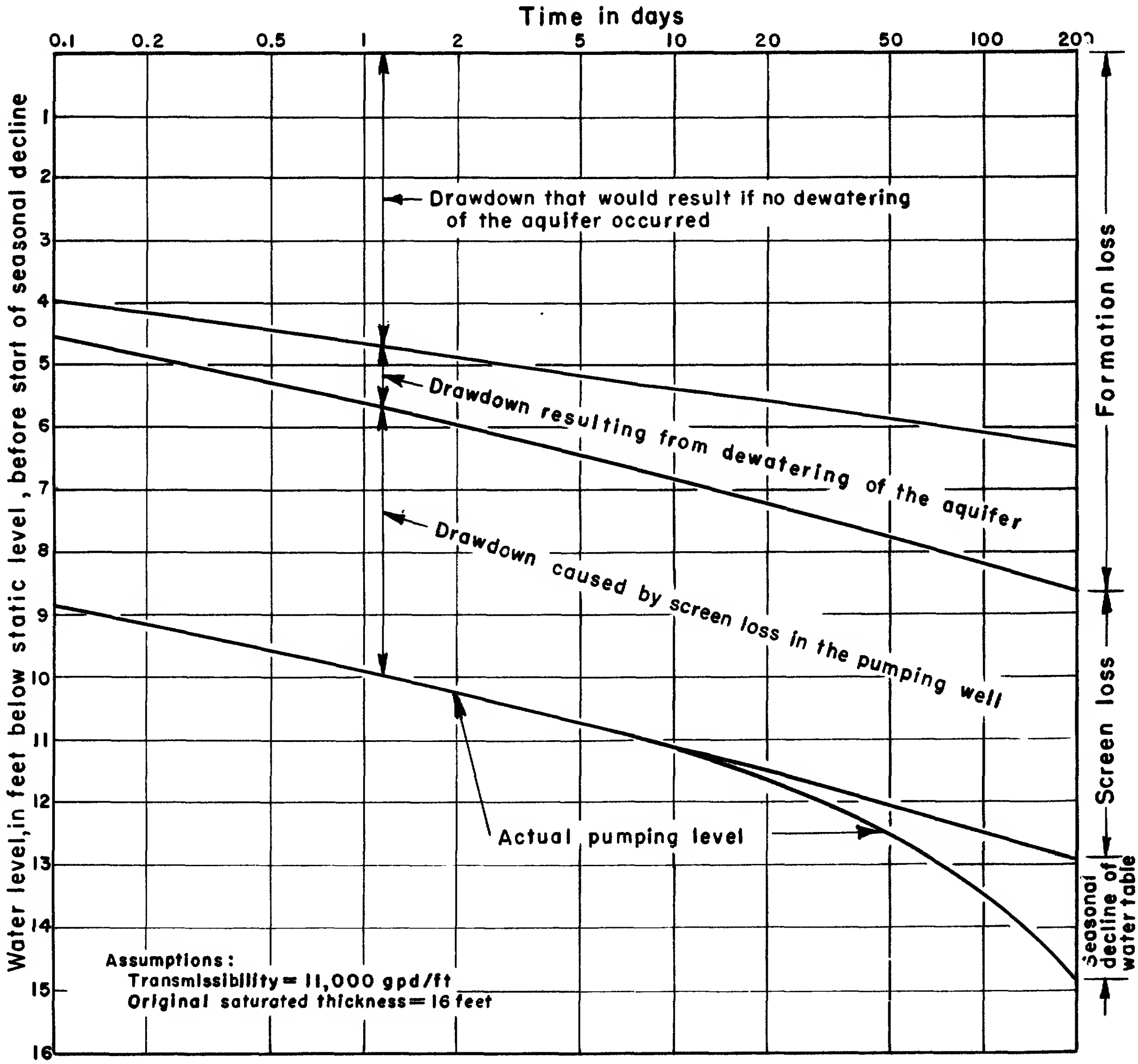

Figure III-19.--Graphs showing components of drawdown in a well 2 inches in diameter which is pumped at 30 gpm for a period of 200 days without recharge. Such a period is probably not too uncommon from May to November. Drawdown in a pumping well 6 inches in diameter would be about 2.5 feet less than that shown for a 2-inch well.

The preceding discussion illustrates how the values of transmissibility and storage are utilized in predicting the drawdowns that will result from pumping one or more supply wells at any rate for any period of time. The discussion considers the yield of a well only from the standpoint of the water-transmitting and water-storing properties of the aquifer. It does not consider the perennial yield of the aquifer. However, in the development of a water supply the yield of an aquifer is, in many cases, equally as important as the yield of a well. The perennial yield of an aquifer is ultimately limited to the quantity of water that reaches the aquifer naturally plus the quantity that can be induced into the aquifer from some external source, such as a stream or lake.

Prior to the withdrawal of water from an aquifer there is a natural balance established between recharge and discharge. During periods when recharge exceeds discharge, as at the time of the spring thaw, the water table rises. When discharge exceeds recharge, as during most of the growing season, the water table falls. The sand deposit in the northeastern corner of the park and the related sand and gravel deposit that underlies large areas in the eastern part of the county are recharged by precipitation. As pointed out in a preceding discussion, precipitation is relatively evenly distributed throughout the year. However, the proportion of the precipitation that reaches the water table varies in response to many factors, including air temperature and the amount and rate of precipitation. Studies of the factors affecting recharge to the sand deposit have not been made and, therefore, only a few general statements regarding recharge can be made. It is obvious from the hydrographs in figures III-8 and III-9 that the sand deposit receives recharge intermittently through the winter months when losses due to evaporation and transpiration are negligible. The melting of the snow cover and thawing of the ground in March and April, before plant growth starts and while evaporation losses are small, result in substantial recharge. Relatively little recharge reaches the water table during the growing season, from May to October. Long-term records of water-level fluctuations in different parts of the State show that occasionally freezing of the ground begins in the fall before soil moisture requirements have been satisfied and, thus, before any significant amount of recharge reaches the water table. If the ground remains frozen, the water table continues to decline through the winter months until the spring thaw. Thus, in predicting the effect of pumping from the aquifer it is not unreasonable to assume that there will be periods of 200 days when recharge is insignificant. (See figures III-18 and III-19.) In general, however, it appears probable that the recharge to the sand deposit will average from 25 to 40 percent of the total annual precipitation from year to year, depending on climatic conditions.

During any period when there is no net change in water levels, as during the period from January to August 1959, the discharge from the aquifer must equal the recharge. Natural discharge from the sand deposit occurs principally through springs, seepage into streams, and seepage along the sides of ravines and, to a lesser extent, through the transpiration of plants that draw from the water table. Thus, measurements of the discharge of springs and streams indicate the quantity of recharge less the part used by plants and less the part that evaporates upstream from the points at which the discharges are measured. The discharge of the two upper springheads on the Wilbur Spring ravine was measured periodically from January to November 1959, and found to be between 25 and 30 gpm (fig. III-8). This represents only a part, and probably only a small part, of the total discharge from the sand deposit in the northeastern corner of the park.

Water pumped from the sand deposit, as from any of the aquifers in the county, is initially derived from storage. This withdrawal from storage causes the water table to decline in the vicinity of the well. The withdrawal of water from storage continues until the cone of depression reaches a source of additional recharge or until natural discharge is reduced. The possibility of increasing the amount of recharge to the sand deposit both in the vicinity of the Wilbur Spring ravine and at most other places in the county appears remote because runoff on the deposit is negligible and the

deposit is generally above the level of streams and lakes that might serve as a source of additional water. Therefore, the water pumped from wells must ultimately be balanced by a reduction in natural discharge. Withdrawals in the vicinity of the Wilbur Spring ravine, for instance, will ultimately result in a reduction in the flow from the ravine and a reduction in the amount of water that presently seeps from the aquifer in the ravine about 400 feet west of well Sa 1065 and along the scarp bordering the flood plain of the Hudson River. The proportion of the pumpage that is derived from each point of natural discharge depends on the location of the pumping wells. The more distant the wells are from the ravine the less the effect on discharge from the ravine.

SUMMARY OF GROUND-WATER CONDITIONS IN SARATOGA COUNTY

Ground water is used extensively in Saratoga County to supply domestic and farm needs. It is also used by a few commercial establishments and small industries. Ground-water supplies in the county are obtained largely from wells although a substantial number are still obtained from springs. Wells draw water either from bedrock or from unconsolidated deposits overlying bedrock.

The bedrock underlying the county consists of granite, gneiss, and other crystalline igneous and metamorphic rocks in the northwestern and north-central parts and shale in the eastern and southern parts. Lying between the crystalline rocks to the northwest and the shale to the southeast is a relatively narrow belt across the central part of the county that is underlain by sandstone, limestone, and dolomite.

Wells drawing from bedrock are generally cased through the unconsolidated deposits and are uncased in bedrock. The average yield of bedrock wells in the county ranges from about 6 gpm in the crystalline rocks to about 31 gpm in the limestone and dolomite (carbonate rocks). Water in quantities adequate for domestic needs can be obtained from bedrock in most parts of the county from wells that penetrate the rocks to a depth of 100 to 200 feet. The greatest difficulty is in obtaining water from the crystalline rocks, especially on the higher hills in the northwestern part of the county.

Unconsolidated deposits overlie the bedrock in most parts of the county. The three principal types of deposits are till, clay, and sand and gravel. In the western and central parts of the county the unconsolidated deposits consist largely of till, an unsorted mixture of rock fragments ranging in size from clay to huge boulders. The till is not a productive water-bearing deposit. However, in most places it will yield sufficient water for small domestic needs to large-diameter dug wells.

In some of the larger valleys in the western part of the county and in much of the eastern part of the county the unconsolidated deposits consist of sand and gravel or sand. These deposits are the most productive sources of water in the county. In parts of the stream valleys in the central part of the county deposits of sand and gravel will yield more than 750 gpm to screened wells. The deposits of sand and gravel and sand in the eastern part of the county are not generally as productive as the valley deposits. However, the sand and gravel deposits are capable of yielding 50 gpm and more to screened wells in many areas.

Much of the eastern part of the county is underlain by clay and silt. The clay and silt is at the surface in the lower areas and underlies the deposits of sand in much of the remainder of the area. Water in usable quantities cannot be obtained from the clay and silt. In those areas in which clay and silt is the only unconsolidated deposit ground water can be obtained only from bedrock wells.

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